Girdling the Earth

To make gestures, sounds, pictures, to talk and write; these are the means of conveying a message. Brush, pen, paper, printing, photograph, telegraph, telephone, radio and television: these are the media of transmission.

This fascinating book explores the whole story of man's endless search for better ways of communication, from his first attempts at speech to bouncing electronic signals from artificial earth satellites circling in outer space. "I think," says the author, "that this book on communication has fascinated me more than any I have yet done. I never realised that there was so much drama in archaeology, and alphabets, or so many surprises in man's struggle to throw his voice."

Perhaps most exciting of all is the final chapter in Mr Neal's book, for we are now in the middle of a communications revolution —pictures and messages circling incessantly and instantly around the world, sometimes by satellite; messages into and from space; and perhaps discoveries in extra-sensory perception or thought transference!

A collection of photo-plates enriches the text which has been edited by Egon Larsen.

COMMUNICATION From Stone Age to Space Age

COMMUNICATION

From Stone Age to Space Age

HARRY EDWARD NEAL

Edited by

EGON LARSEN

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INTRODUCTION

You and I have been taught to make certain voice noises that we call speech, and to read and write what we call words and sentences. Through the words and sentences on this page and the pages that follow I am 'communicating' with you.

To people in Greece or some other land overseas our voice noises are merely meaningless sounds, and the words we write in English are only strange combinations of marks or letters, just as their language and writings, as the saying goes, would be Greek to us.

Foreign tongues are being taught in most countries of the world, because modern transportation and modern electronic inventions have made all parts of the globe easy to reach, and we realize that communication among nations is of the greatest importance to world peace, world trade, and the advancement and preservation of our civilization.

Tremendous progress has been made in methods of communication, but it has taken man thousands of years to plod from his first meaningless utterance to our own era of world-wide television via satellites.

In this book I have tried to tell the whole story of human communication and to show how it affects our daily lives. The stories of sign languages, hieroglyphics, pens and pencils and paper and ink; of the slave who invented shorthand; of the printing press, the telegraph, the telephone, radio, and television; and of the amazing developments being planned for communicating through outer

space—all made this book one of the most fascinating I have ever tackled.

If you read it with nearly as much pleasure as I had in putting it together for you, as I hope you will, then it will have been worth while for both of us—for most writing serves no purpose unless and until it communicates.

HARRY EDWARD NEAL

1

GRUNTS, GIGGLES, AND TALKING HANDS

The Bible says that the first words ever spoken by a human being were names given to 'all cattle, and to the fowl of the air, and to every beast of the field' by Adam, the first man. And the first quoted words of the first man, spoken just after God had created Eve, the first woman, were: 'This is now bone of my bones, and flesh of my flesh; she shall be called Woman, because she was taken out of Man' (Genesis ii.23).

Some scientists do not agree with the Bible statement: 'And the Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul'. Many are convinced that man developed, instead, from some lower form of life, such as the anthropoid apes, and that his transformation from beast to human began about a million years ago.

It isn't our purpose to argue about the evolution of man as such. This book is about another kind of evolution—the evolution of speech and of writing and of other forms of communication that have, in our own time, brought all nations, all peoples, closer to one another.

Communication has made possible our great industries; our commerce with other nations; our improved transportation, modern methods of agriculture, education, science; our entertainment and recreation. It is the real basis for our standards of living.

Scientists, including anthropologists (who study the origin and development of mankind), believe only what they see or what can be proved. No one has yet discovered any tangible evidence to prove the creation and existence of Adam, but science has dug up fragments of the bones of four creatures classed as those of the 'Java Man' because they were found in Java; and experts have established that the Java Man, one of the 'most primitive manlike forms yet discovered', lived during the first interglacial period, about a million years ago. From skull pieces they have built up his face as they think it looked. I have seen replicas of the skull fragments and the reconstructed face, which show that the Java Man was apelike in appearance, with a low forehead, big ridges over his eyes, and heavy neck muscles.

Whether we believe that Adam was truly created from dust, or that our ancestors once lived in trees, it seems pretty reasonable to assume that the first humans had considerable trouble in exchanging ideas or in expressing their thoughts to each other.

Suppose that the Java Man could think and also had the power of speech; that is, that he could make a variety of noises with his vocal cords. If he were only beginning his development as a human being he certainly knew nothing of words or intelligent speech. Since his world was inhabited largely by wild animals, however, he undoubtedly was familiar with the sounds of the snarl of the leopard, the snort of the wild pig, the cry of the peacock, and the noises made by the brontosaurus or other creatures of the jungle. He knew the sighing of the wind in the trees, the gurgle of running brooks, the crack of stone upon stone. These, then, were probably the noises he first imitated in 'speaking' to another Java Man—or to a Java Woman.

Picture the Java Man and Java Woman seated at the entrance to their cave. Both have eaten their fill from the carcass of a small deer slain by a heavy rock in the hairy hand of the hunter. The man belches and looks at the

woman. She rises and starts for the cave, but he holds up one hand and she stops.

He says	*As he*
Um . . .	raps his chest with his fist.
slup-slup.	makes a sucking sound through his teeth.
Oom . . .	stretches one arm towards the woman.
gluggle-gluggle-gluggle.	swings the same arm sideways to point into woods.

Silently the woman walks away into the forest and soon returns with a huge green leaf carried in such a way that it holds water she has dipped from a nearby brook. She gives it to the man, who drinks it.

The Java Man's conversation had run like this: 'I (Um) am thirsty (slup-slup). You (Oom) go [get] water (gluggle-gluggle-gluggle).'

To make his meaning clear, he accompanied his words with gestures—fist on chest, meaning 'I, me'; sucking sound through teeth, meaning 'thirsty, drink'; arm pointed at woman, for 'you', and then extended in the direction of the brook, meaning 'go that way'. His 'gluggle' was his imitation of the sound of the running brook; that is, his word for 'water'.

All this may sound funny or far-fetched; but it isn't, and today you and I act in very much the same way. We say, 'May I have a drink of water?' These words are very familiar to us because we have learned their meanings, but to the Java Man—or even to a Chinese or an Arab not familiar with English—they would make no sense whatever. Where we say *water*, the Spanish say *agua*, the French *eau*, the Germans *wasser*, the Icelanders *vatn*—and other nationalities have different names for the same liquid.

The point is that we have learned a 'language', which

means merely that we have learned to make certain noises with our voices that have specific meanings to us and to others around us. The primitive man did exactly the same thing, except that he used different combinations of sounds, and he also clarified his meanings by using gestures, or signs, as we frequently do.

Gestures include facial expressions, which tell a great deal. Even young children scowl when they are displeased and smile when they are happy. We raise an eyebrow to signify that we are surprised, or wrinkle our brows if we are puzzled. If we smell an offensive odour we 'make a face' and may also clamp our noses between our thumbs and forefingers. The guest who finishes a big meal might lean back in his chair, grin, and pat his stomach gently with an open hand, meaning 'That was most enjoyable, and I am well filled'. Sir Winston Churchill made good use of gesture during World War II by holding up the first and second fingers of his right hand in a 'V' for 'Victory' whenever he faced a crowd. Every day every human being uses some gesture or sign in his conversation with others, and this has become so natural that we are not conscious of the fact that we are harking back to the days when some people could understand others only by using no words at all—only a sign language.

Sign-talk was used extensively by the American Indians, mostly because there were so many tribes with so many different languages that it was very difficult for them to understand one another's spoken words. There were variations in some signs, also, but generally they were picturesque enough to be understood, even by the white man.

A sign for *sun*, for instance, was made by forming a circle with the forefinger and thumb of the right hand, raising the hand about a foot above the face and looking up through the circle. Simply by separating the finger and thumb to form a 'C', or crescent, we have the sign for *moon*.

Here is part of a voiceless conversation between a Pah-Ute (Piute) Indian scout and a frontier Army officer:

INDIAN: Extends right arm forward full length; closes right hand except for index finger, which points westward; head up, he looks in direction he is pointing.
('*Away to the west . . .*')
He spreads right thumb and index finger apart slightly and draws them across right side of his forehead (signifying the brim of a hat or cap), then holds up one index finger.
('*. . . a white man . . .*')
He sticks out left forefinger, then makes a 'V' with the first and second fingers of his right hand and straddles the outstretched left finger with the inverted 'V' (representing a horseman), then makes two or three arched movements to the right with his hands.
('*. . . rides horseback . . .*')
Now he makes a peculiar whistling sound like 'Whew!' through his teeth as he draws his right forefinger across his throat from left to right (symbolizing the Bannock tribe, known for cutting its victims' throats).
('*. . . with Bannock warriors.*')

OFFICER: Holds open right hand upward vertically, edgewise towards Indian, waggles hand three or four times slightly to left and right.
('*When? How long ago?*')

INDIAN: Holds palm of right hand open close to right cheek; then inclines head slightly toward palm, and holds up two fingers.
('*Two sleeps.*')
He makes a semicircle with the thumb and forefinger of his left hand, holds the open ends of the 'C' against his breast, then puts index finger of right hand inside semicircle and moves the finger from one side to the other to show it cannot escape.
('*He is their prisoner.*')

OFFICER: Repeats the sign for 'When?' (or 'inquiry'), then rapidly opens and closes fingers of his hand two or three times.
('*How many braves?*')

INDIAN: Puts both hands against chest, palms outward, fingers apart with thumbs touching. Then closes both hands except for the index finger on each.
('*Twelve.*')

Such a conversation would take place within a minute or two and could go on to deal with many other aspects of the scout's observations, all without a single sound.

The sign language was an asset to the Indian in war or peace. In war he could sneak up on an enemy and give orders to or exchange messages with his nearby concealed friends without a sound. In a peaceful bear hunt he and his fellow hunters could stalk an animal and 'talk' about their best approach without using voices that would startle the quarry.

There were disadvantages of course. The sign-talker could not use his hands for other things while he was 'speaking'. He could not use signs at night, except by the light of a camp fire, nor could he stand outside a tepee and 'talk' to someone who was inside and who could not see his hands.

The hands are vitally important today for communication among people who are deaf or hard of hearing, and the sign language of the deaf is almost as picturesque as that of the red man. Hold your left forearm across your waist, to represent the horizon. Now, with your right hand open and the fingers close together, pass the right hand downward past the outer surface of the left forearm, finger tips pointing at the floor. This is the sign for *sunset.* For *sunrise,* with the left forearm in the same position, bring the open right hand under and upward—just the reverse of the first sign.

The sign for *man* (in one of the widely used sign languages): The thumb and forefinger grasp the brim of an imaginary hat (similar to the Indian sign).

The sign for *woman*: The side of the right thumb is placed at the right temple and brought downward to the chin, symbolizing the ribbon that women once used for tying on their sunbonnets.

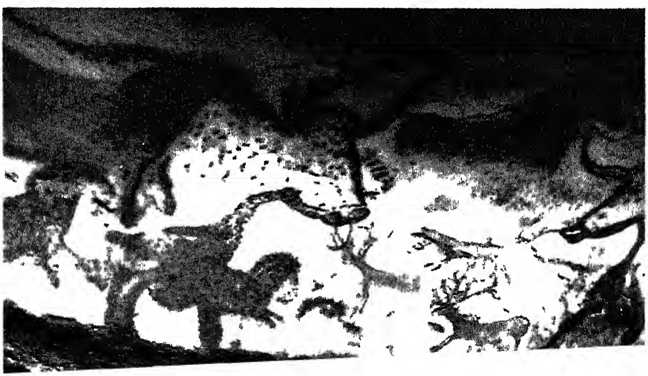
For the deaf sign language the world is indebted to two French priests of the eighteenth century, the Abbé Charles Michel de l'Épée and the Abbé Roch-Ambroise

A group of deaf, deaf-blind (*centre*), and hearing people communicating with their hands.

The sensitive hands of a blind man reading Braille.

(1) Killed two Arickarees, 1853 (2) Shot and scalped a 'Ree' (Arickaree) (3) Shot a 'Ree', 1853 (4) Killed two warriors, one day, 1854 (5) Killed ten men, three squaws, 1856 (6) Killed two chiefs, 1856 (7) Killed one 'Ree', 1857 (8) Killed one 'Ree'. 1859 (9) Killed two 'Ree' hunters, 1859 (10) Killed five 'Rees' in one day, 1863 (11) The last 'Ree' killed, 1863

Pictorial communication in the Stone Age cave paintings at Lascaux, France.



Cucurron Sicard. The Abbé de l'Épée, 'Father of the Deaf', devoted his life to their needs, but only accidentally hit upon the idea for an alphabet and sign language.

A stranger offered to sell him a book by Don Juan Pablo Bonet, a Spaniard. The Abbé could not read Spanish and did not want the book until he chanced to thumb through it and saw some diagrams for a one-handed alphabet. He not only bought the book but also learned Spanish, English, German, and Italian to read what others had written about the deaf. Then he created a language of signs and spent his life teaching his deaf pupils how to express ideas through this medium. When he died in 1789 his work was continued by the Abbé Sicard, who improved upon his ideas and developed new signs to perfect the language of symbols.

A person who is expert in the use of the sign language and alphabet for the deaf can 'speak' as rapidly as any normal individual, and perhaps faster than some. In certain respects the hand-speech of the deaf is clearer than the spoken word. Teaching the deaf to speak reveals many inconsistencies in our English language.

There are, for example, the confusions which come from the sound of 'ch'. On the lips, 'ch' and 'sh' look much alike, and to a child born deaf, who has never in his life heard a word spoken, it is upsetting to spend arduous months learning the 'ch' sound only to come across the word 'yacht'. Try to explain to a deaf boy why we don't always pronounce the 'ch' in such words.

'The language is full of other confusions to the deaf', says Dr Leonard M. Elstad, a teacher of the deaf. 'Words like *mould* and *could*, or *freak* and *steak*, for instance. The other day I picked up a newspaper and read a headline: *Blue Baby Now in the Pink, Goes Home.* I thought it was a story about a racehorse! Some time ago when I was teaching in school one little fellow was absent one day. When he came to class I asked where he had been. He was ill, he said—he had a "cow in the box". That floored me

until I asked him to spell it out. Then I found that he had a cough in the chest. He knew that *bough* was *bow*, so *cough* must be *cow*! A *chest* was a *box*—he had a cow in the box.'

To the deaf English is a foreign language, and many must learn it without ever having heard it spoken. If a student deaf since birth or infancy were suddenly to be given hearing, he would be as helpless as the Java Man to interpret the sounds he heard. He could, however, recognize many signs familiar to all of us in our everyday lives.

Remember how the Java Man, by holding up one hand, ordered his woman to stop? Our modern traffic policeman stops a whole line of motor-cars by the very same motion, and we have also been taught that a green traffic light means 'Go', a red one 'Stop'.

Often when we say 'No!' we shake our heads from side to side, or when we say 'Yes' we nod.

If we are asked a question to which we don't know the answer, we may merely shrug our shoulders or hold out the palms of our hands and make no sound at all.

Directors of radio and television programmes use a variety of signs—stretching an imaginary elastic band means 'String it out; we have plenty of time'; cutting a throat with an imaginary knife, or pointing to one's wrist watch, means 'Cut it short; time's about up!'

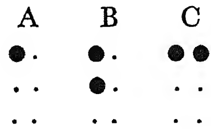
We teach babies to wave 'Goodbye' even before they can say it.

To see how important—and how automatic—gestures have become in our own day, ask a friend to describe a spiral staircase or an accordion!

In describing objects or scenes to persons who are blind, gestures are of little use. Those who live in a sightless world, however, may still learn much about it by listening to other people or by 'seeing' with their finger-tips as they read books printed in Braille.

Braille is a special alphabet in which letters are formed by special combinations of up to six raised points, or dots.

The Braille letters A, B, C, for example, are printed like this in the dot pattern:



The dots can be arranged to form sixty-three different symbols. The blind 'reader' feels the raised dots with the finger-tips of both hands, letter by letter, line by line, substituting his sense of touch for the sight he lacks.

One of the first systems of reading for the blind consisted in carving the letters of the alphabet on blocks of wood, arranged in words and sentences, but this was cumbersome and costly. In 1640 the same idea was tried with movable lead type, followed by pins stuck in pincushions, letters cut from cardboard, wooden blocks, and other unwieldy methods.

One day in Paris, about 1784, a man named Valentin Haüy saw a group of blind beggars in fantastic costumes making weird noises which were supposed to be songs, in an effort to collect alms from passers-by. Haüy became especially interested in a young blind boy, François Lesueur, who was one of the beggars. Haüy approached the youth and offered to pay him if François would agree to let Haüy teach him to read and write.

The teaching involved the use of customary block-letter methods—but one afternoon young François was clearing some papers from Haüy's desk and noticed that one of them felt rough. On closer inspection he found that the roughness was due to extra-heavy pressure that had been applied to the paper in the printing press, so that the outlines of the printed letters were deeply impressed into the paper. By touching each letter the boy was able to 'read' the printed words, and gleefully he rushed to his teacher with this startling news.

Haüy used the handle of a pen to emboss some letters and signs on a sheet of paper, which François read correctly and quite promptly. The teacher was convinced that they had found a better way to communicate with the blind, and he developed a system of printing books in relief and opened a school for blind children.

Haüy's process was approved by the Academy of Sciences, was adopted in many countries, and he was later acknowledged to be 'Father and Apostle of the Blind'.

In a few years more than twenty different methods of embossed printing for the blind were in use throughout the world. Probably the best known of these is the Braille system—developed by Louis Braille, who went blind when he was only three years old. Braille, an accomplished organist, was a pupil and later an instructor in the school started by Haüy.

Contrary to popular belief, Braille was not the inventor of his system. The method of using a raised-dot alphabet was conceived by Captain Charles Barbier, another Frenchman, but the system was quite complex and it remained for Braille to simplify and improve it so that it could be mastered without great difficulty.

By means of a ruler-like metal guide punched with six small holes in the basic Braille pattern, the blind may write as well as read in Braille. Even without sight they can know more about their world than did the first humans who could see.

Whether the first humans were Adam and Eve, or the Java Man, or some other group, how did they teach their speech sounds to others, and how is it that we have so many different languages in the world today? Some scholars believe that gradually the first humans drifted off in different directions, seeking new hunting grounds, new shelters, or even new places to see. Many thus came upon new and unfamiliar objects to which they gave new names. Some groups met others and learned new sounds

from them. Some fought invaders or became invaders themselves, acquiring new additions to their vocabularies from their opponents; and eventually, through centuries of time, whole new languages came into being.

Scientists in the United States, Britain, and Russia have recently developed electronic 'brains' that will automatically transform English or Russian words into words of another language, or *vice versa.* Although this electronic translation is crude (resembling the 'broken' speech of a foreigner), it is hoped that the devices will eventually reach a higher degree of perfection; they may prove invaluable in the rapid exchange of ideas among the people of all nations.

It is sometimes difficult to express exact meanings in translating thoughts from one language to another, since one language may not have words that convey the true meanings of the original. For example, an American tourist travelling in Asia decided to send a note to a Chinese friend in the United States. He asked a Chinese in Hong Kong if he could write the proverb 'Out of sight, out of mind' in Chinese. After some deliberation the Chinese wrote the characters representing this saying, and the tourist sent it to his friend back home. Later he discovered that the literal translation of the Chinese characters was 'invisible idiot'!

Today man is still hopeful that he may develop and use a universal language—a way of speech that would be understandable to all nations and all peoples. Since the seventeenth century more than a hundred schemes for such a language have been suggested and discarded.

In 1817 François Sudre, a Frenchman, devised a language based upon the seven notes of the musical scale: do, re, mi, fa, sol, la, te. Like other 'universal' systems, Sudre's required a phenomenal memory and was too complicated to be practical.

One method, called *Volapük*, was invented by Father Johann Martin Schleyer, an Austrian Catholic priest,

about 1880. He based his words on those in various languages, including English, but so distorted them that they bore little resemblance to the original roots. Volapük, for example, meant 'world speech'.

Volapük was difficult to learn, yet thousands of people began to study it, and within ten years there were organized groups of students in many areas of the world, and a Volapük Academy had been started to extend studies of the language. When the academy suggested that the language was too complicated and should be modified, Father Schleyer disagreed and refused to let anyone tamper with his creation. The academy promptly closed its doors and Volapük gradually faded into obscurity.

In 1887, even as Volapük was gaining new supporters, a young Polish Jew named Louis Lazarus Zamenhof introduced another artificial language called the *Lingvo Internaciona de la Doctoro Esperanto* (International Language of Doctor Hopeful), soon shortened to *Esperanto.*

Esperanto was considerably easier to learn than Volapük, with words based on the roots of a number of European languages. Today Esperanto is taught in many commercial, private, and evening schools (the London Chamber of Commerce holds examinations in this language); a number of radio stations all over the world have Esperanto programmes, and it is recognized by the Post Office as a 'plain language' for telegrams. As with any proposed universal language, many scholars came forth with suggestions for its simplification but, although more than fifty such proposals have been made regarding Esperanto, only one, called *Ido*, has shown any real promise of improvement.

Some authorities believe that a universal language called *Interlingua* is the best that has yet been devised. Proposed in 1903 by Professor G. Peano, Interlingua grew from work of the International Research Council in 1924, with the co-operation of the International Auxiliary Language Association. It is based upon Latin

root-words in all European languages, but considers unnecessary any verb conjugations, gender, or agreement of adjectives. Interlingua has proved to be useful in various scientific and technical fields and has been used successfully in international scientific journals, eliminating the need for printing articles in several languages, which would be costly.

No one knows whether Interlingua or Esperanto or some other artificial language will come into universal use. We do know that from the Java Man down through the centuries of primitive cultures people did manage to understand one another by grunts, giggles, and talking hands—but there was one great lack in this kind of communication. There was as yet no permanent record of ideas, or discoveries, or of day-to-day happenings of importance. Gestures and noises were made and soon forgotten—until the day came when man first felt impelled to leave some recorded evidence of his accomplishments, some account that other people could see and understand without having to listen to his voice or watch his hands and face.

2

MIXTURES OF PICTURES

THE EARLIEST men roamed the forests seeking food and shelter, and more than one unwary hunter was caught and chewed up by a hungry sabre-toothed tiger or killed by an angry rhinoceros or a mammoth. On the other hand, beasts were also killed, either by each other or by man.

Somewhere along the dim historic line a primitive hunter slew a deer and decided to boast about his kill. He broke off part of the animal's horns and then, using a sharp piece of flint, scratched a crude picture of his kill into the antler fragment. To make his meaning clear he scratched the image of a spear, with the point at the animal's side. He carried his horn-drawing away with him to show the other men back at the cave—much as a modern sportsman preserves the head of a deer he has shot, to decorate the wall of his trophy room and perhaps to brag a little.

We can't be sure whether the first picture was on an antler or on a cave wall, but this is a reasonable explanation of the way picture-writing probably began; in fact, one of the earliest existing records of any actual event is a picture scratched on an antler—showing a hunter about to heave a spear into a grazing aurochs, or wild ox. The piece of antler with this drawing was found many years ago in a rock shelter in the Auvergne region of France. Caves in other countries have yielded pictures of the mammoth, the seal, the bear, and other animals.

At first the primitive 'artists' carved images of standing or dead beasts, or of standing or sitting human figures. While it was an achievement of sorts to make any picture that other people could recognize, the real accomplishment came when the carvers began to show animals running or jumping or fighting, and also to show men chasing the creatures or being attacked by them or engaging in some other kind of action *that told a story.*

Story-pictures began to reveal more and more about the daily lives of the people who made them, and as a result we have learned a great deal about what they did and how they did it—not only in Europe but also in Asia, Australia, and America.

The American Indians developed not only a good sign language but a good system of sign-writing as well. A small circle with lines radiating from it (the sun) meant 'day'. A circle with one side showing a crescent (the moon) was 'night'. A triangle, pointing upward, with a short vertical line in the centre of its base, was 'tree'—and three or four trees meant 'forest'. 'River' was simply two or three wavy horizontal lines, representing water. A figure like an upside-down capital 'A' (∀) was a picture of a cow's head and was the Indian's sign for 'cow'. If he wanted to say 'three cows' he would simply draw three short vertical lines under the sign, just as he might draw seven lines under the symbol for 'sun' to indicate 'one week' (seven days).

The Plains Indian who made his home, or tepee, with animal skins had a good surface on which to draw his pictures, and many were drawn or painted on these hides; but he found that the bark of the birch tree was even better—much smoother, more plentiful, and easier to handle.

Gradually the cave man, the Indian, and other picture-writers simplified their drawings by using symbols in place of actual objects. For instance, the Indian made a picture of a pipe to symbolize 'peace'—since the smoking of the

peace pipe was well known among the tribes as an act of friendship. A bird on the wing indicated 'haste', and a camp fire meant 'family gathering'. The picture of an eye with a horizontal wavy line ('water') running through it meant 'wet eye', or 'weep'.

Some of the best descriptions of Indian symbols are found in Henry Wadsworth Longfellow's poetic story of *Hiawatha*:

> Gitche Manitou the Mighty
> He, the Master of Life, was painted
> As an egg, with points projecting
> To the four winds of the heavens.
> Everywhere is the Great Spirit
> Was the meaning of this symbol. . . .
> Life and Death he drew as circles,
> Life was white, but Death was darkened. . . .
> For the earth he drew a straight line,
> For the sky, a bow above it;
> White the space between for daytime,
> Filled with little stars for nighttime;
> On the left a point for sunrise,
> On the right a point for sunset,
> On the top a point for noontide
> And for rain and cloudy weather
> Waving lines descending from it. . . .

Another kind of Indian symbolism was the carving of images on trees or logs—figures representing people, birds, or animals, even mythical beings. The images, carved one above the other from bottom to top, were painted with bright colours and usually were symbols of events in the life of a family or clan, or perhaps were used to record legends or tales the people did not want to forget. Many North American Indians used natural objects such as animals or birds as their tribal emblems, and in Indian language these objects were called *totems*. Since the images of the totems were usually carved on the trees, these upright wooden story-books were called 'totem poles'; some of them may still be seen in the north-west

coastal areas of the continental United States, in Canada, and in Alaska.

Pictures which symbolize ideas are called *ideograms*, or representations of ideas. Though they were common to the American Indians, ideograms were widely used by other peoples—especially the Chinese, who made combinations of simple pictures to express complicated ideas. A Chinese drawing of two hands joined together meant 'friend'. If it was accompanied by a picture of a knife (meaning 'divide') and the symbol for money, it would be read as 'friend who is poor'.

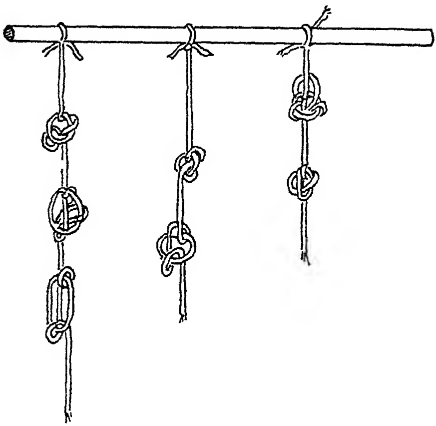
Although many of the Chinese signs were gradually simplified and changed, more than forty thousand of them are in use today; for Chinese is a language that is still written in ideograms, or picture symbols. Not all of the forty thousand characters are in frequent use, but in order to read or write letters, or stories, or books, a Chinese must memorize at least six thousand or seven thousand of the symbols. This demonstrates the great advantage of an alphabet that uses symbols for *sounds* rather than for ideas or objects.

The carving or writing of pictures and symbols not only recorded important events but also helped people to remember them. One of the most unusual memory aids was probably the *quipu*, used more than a thousand years ago by the ancient Incas in Peru. The quipu did not involve writing of any kind. It was simply a series of strings or cords of different colours fastened to a stick. Knots were tied in the strings as a kind of primitive accounting system—a single knot represented 10, a double knot 100, a triple knot 1,000. Two single knots in one cord, close together, stood for 20, two double knots for 200, and so on.

The quipu was used primarily to keep track of supplies, money, and the ancient Peruvian army. A red string was used for 'soldiers', yellow meant 'gold', white was 'silver', green was for 'corn', and other colours

represented other necessary items. Special knots on the 'soldier' string showed the number of warriors armed with slings, the number carrying spears, and those who wielded clubs.

Since the tying of special knots in certain ways was the basis for keeping accounts straight, the Incas designated experts to perform this task—calling them *quipucama-yocuna*, meaning 'officers of the knots'.



Peruvian Quipu

Although the quipu was used officially for government purposes, it was also used informally by the Peruvians to keep track of weddings, births, deaths, and other family matters. An American ethnologist, Dr Garrick Mallery, recorded in 1893 that the quipu was still used by shepherds. 'On the first branch, or string', he reported, 'they usually place the number of bulls, on the second the cows, on the next the calves according to their ages and sizes. Then came the sheep, the number of foxes killed, the quantity of salt consumed, the cattle that had been slaughtered.'

Obviously all of this information could not be accurately memorized, and the quipu was merely a method to help the Peruvians remember. Perhaps it wasn't too far

removed from the custom still practised occasionally by some of our own people, who tie knots in their handkerchiefs as a reminder to post a letter or make a phone call.

Much more advanced than the Peruvians were the ancient Egyptians, who carved picture symbols into rocks more than five thousand years ago. The first symbols were recorded by priests and were therefore called *hieroglyphs*, meaning 'sacred writings'. These are among the most ancient of all human written records.

The Egyptians, like the Chinese, began with crude pictures of objects, such as a small circle with a dot in the centre for 'sun'. Next they progressed to combinations that expressed ideas: a goat or a calf running towards water (three horizontal wavy lines) meant 'thirsty'; a picture of two arms, one holding a spear and the other a shield, stood for 'battle'.

Later, however, the Egyptians took a tremendous step forward in communication by mixing their pictures of objects and ideas with certain symbols to represent *sounds*. One of their picture-sounds, indicating that they had a sense of humour, was for the Egyptian word *khesteb*, meaning 'lapis lazuli'. In writing this word they used the symbols for *khesf*, 'to stop', and *teb*, 'pig'. Together these symbols read *khesfteb*, literally 'stop pig'. The symbols themselves show the figure of a man holding a pig by the tail! The important thing was that, by putting together the sounds indicated by a group of symbols, a person familiar with the system could read a word and also speak it aloud.

Egyptian writing advanced from hieroglyphic to *hieratic* ('priestly') writing. Hieratic symbols were simplified forms adapted from the hieroglyphs, and could be written with greater ease and speed. Although the system was first used in writing sacred documents, it was soon adopted by government officials for preparing important records.

Hieratic symbols were made still simpler by various changes and led to a third kind of Egyptian writing called

demotic, meaning 'popular' or 'of the people'. Demotic symbols were used by those in all sorts of everyday commerce, for business and personal correspondence, contracts, account-keeping, and other general purposes.

In later centuries, when ancient Egypt had vanished, people of other civilizations who came upon the hieroglyphic, hieratic, and demotic scripts were completely mystified and unable to interpret them fully. Not until 1799 was a discovery made that produced clues toward solving this fascinating puzzle.

The discovery was quite accidental. Napoleon Bonaparte, Emperor of France, seeking to rule the world, had sent his armies into Egypt and other countries. One day a young French officer named Boussard was walking near Fort St Julien, about four miles north of an Egyptian village called Rosetta, when he noticed a rather shiny black stone partly buried in the ground. It was a big stone—nearly a foot thick—and one side of it was completely covered with carved symbols. Many of them were like the hieroglyphs he had often seen on the Egyptian tombs and walls, but others seemed quite different. He dug the stone out of the ground and found that part of it had been broken off. When it was later measured the remaining piece was found to be forty-five inches high, twenty-eight and a half inches wide, and eleven inches thick.

Lieutenant Boussard reported his discovery to his commander, who went to see the stone and had it carried to his quarters—deciding to keep it for himself, perhaps to sell it if it proved to be of value. Word of the find reached Napoleon, who ordered the stone to be held for study by experts he was sending from France.

The experts found that the carved letters in the stone were in three separate sections and that one of these sections was in Greek, with which they were familiar. The Greek inscription was actually a decree of the priests concerning the celebration of the birthday of the Egyptian

king Ptolemy V (Epiphanes) and it had been recorded on 27 March 196 B.C., during his reign.

The Greek inscription ended by saying that the other two sections of carved letters told the very same story in Egyptian symbols, but Napoleon's experts seemed completely mystified when they tried to match the hieroglyphs with the Greek letters. No real progress was made until Napoleon was defeated by the British, who took possession of the Rosetta Stone and shipped it to London (where it can be seen in the British Museum).

In London a scholar named Dr Thomas Young made a study of the stone and managed to determine the sounds that were represented by a few of the Egyptian hieroglyphs. Many other experts tried and gave up, and it remained for a Frenchman, Jean François Champollion, to make the discoveries that were to pull away the curtain of mystery and reveal the history of ancient Egypt through a translation of its early writings.

Champollion was a youthful genius. When he was only nineteen he was a fully fledged professor of history. He became a specialist in Egyptian history and culture, and eventually set about making a careful examination of the Rosetta Stone. Guided by the Greek inscription and by Dr Young's studies, he began to decipher the hieroglyphs. The carving of an eagle, he discovered, represented the letter A. An owl stood for M, a small square was P, a cord with a knot and noose was O, and the figure of a man with hands uplifted meant 'pray'.

Recognizing the Greek letters for proper names, such as Ptolemy and Cleopatra, Champollion examined monuments in the Nile Valley which carried the mysterious symbols believed to represent names of royalty. It was not difficult to separate these names from the rest of the inscriptions, because Egyptian royal names were always enclosed in an oval border, or cartouche, designed to keep them distinctive and apart from symbols for ordinary things.

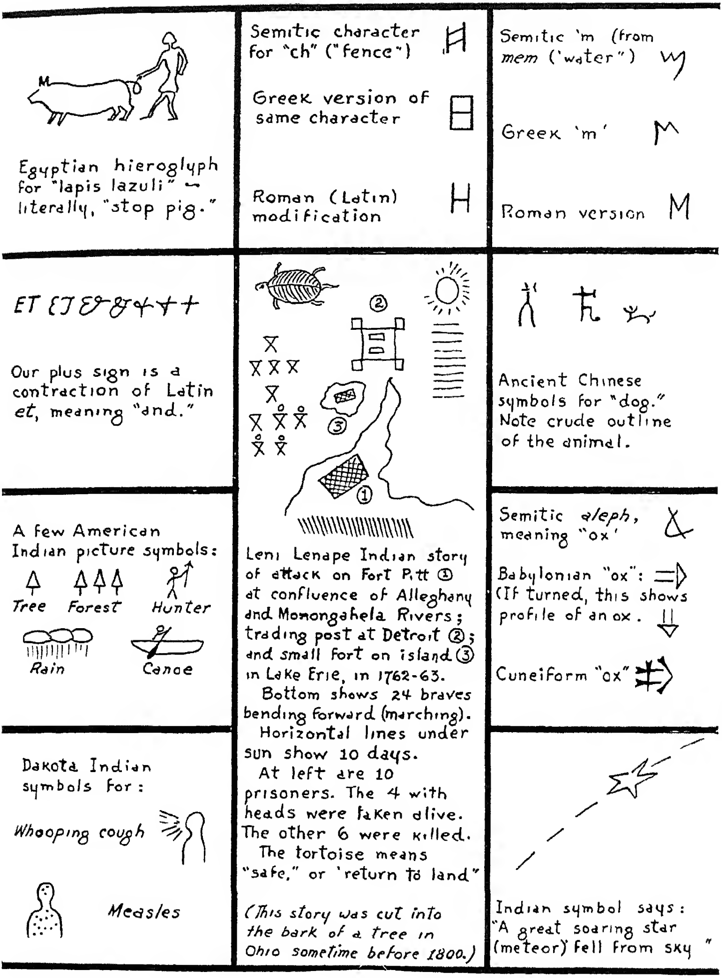
Fortunately the names of Ptolemy and Cleopatra have some letters in common ('e', a leaf; 'o', a noose; 'l', a lion; 'p', a square), and Champollion used these as clues to deciphering the rest of the symbols. Little by little, picture by picture, Champollion interpreted many of the hieroglyphs, and in 1822 he announced his findings to his fellow scholars. Others succeeded in unlocking the rest of the secrets of a lost civilization after his death in 1832.

The writings on the Rosetta Stone, in addition to the Greek, consisted of the early hieroglyphic and the later, simplified, demotic symbols, all telling the same story. Had the stone not been found and made available for study, scholars today might still be puzzling over the meaning of the ancient Egyptian hieroglyphs. As it was, it took the experts more than twenty years to find the right clues and fit them together properly.

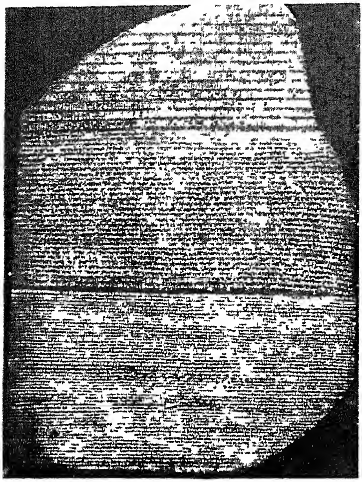
Another kind of carved symbol was also puzzling to scholars. These carvings were found both on stone and on thick clay tablets, some smaller than your hand, others as big as a pillow. They were made up of small pointed markings shaped like thin wedges, and because of this peculiar shape they became known as *cuneiform*, from the Latin *cuneus*, meaning 'wedge', and *forma*, 'shape'.

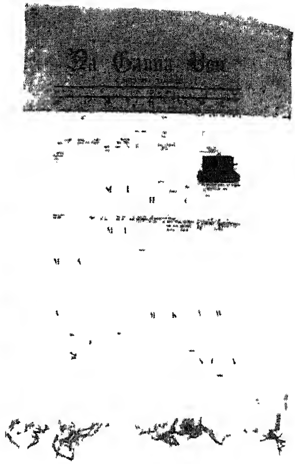
One cuneiform marking looked something like a magnified exclamation point without the dot at the bottom. Another type of mark resembled a chevron except that it was turned sideways, with the point to the right or left.

Cuneiform writing is believed to have originated in Sumeria, or Babylonia, an area between the Tigris and Euphrates rivers, which today is in the country of Iraq. More than five thousand years ago the Sumerians used picture-words to convey sounds and meanings, much as the Egyptians did with their hieroglyphs; but there was one big difference. The Egyptians leaned strongly towards the use of consonants, leaving it to the reader or speaker to insert vowels when and where they were needed. The Sumerians, on the other hand, stressed the use of vowels



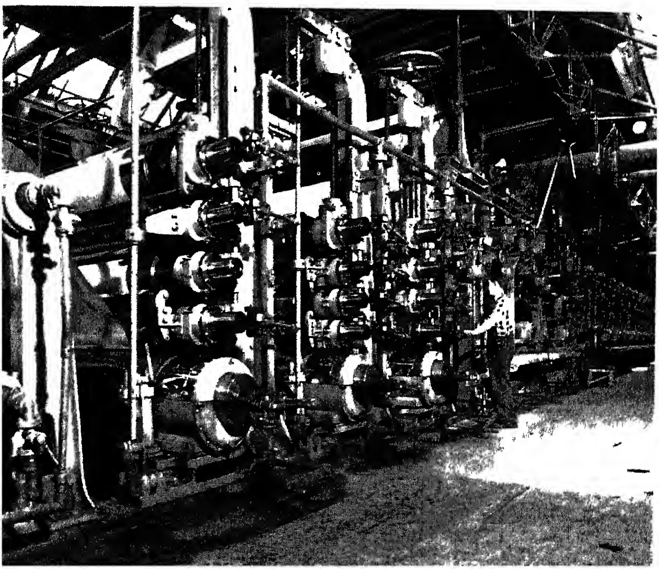
Examples of early hieroglyphs and drawings.





LEFT. The Rosetta Stone, inscribed with early Egyptian hieroglyphs, demotic symbols, and Greek, all telling the same story.
RIGHT. A newspaper printed on bark, from Fiji.

Part of a modern paper machine capable of producing 120 miles of printing paper a day.



and made up symbols for scores of syllables combining every consonant with every vowel. A picture for the sound of R, for instance, would be combined with others to produce Ra, Re, Ri, Ro, and so on.

This presented one serious difficulty. One symbol might have several different meanings. The cuneiform mark for 'foot' was originally a picture of a leg. The word for 'foot' was *su*, but *su* also meant 'overthrow'. Sometimes the symbol was used to express one or the other of these meanings, but again it was used as a syllable for some quite different word; and since the same thing applied to many other symbols, one could never be absolutely sure of interpreting the marks accurately.

An ancient tale shows how disastrous a wrong interpretation could be. About 512 B.C., Darius the Great, King of the Persians, led an army across the Danube and attacked the region north of the Black Sea then known as Scythia, apparently to put down aggressive tribes of nomads roaming the area. As Darius drew nearer and nearer to the enemy, a courier came to him with a message from the enemy commander. Instead of carving pictures of objects into stone or clay, the enemy commander sent Darius the objects themselves—a mouse, a frog, a bird, and some arrows.

According to one version of this story, Darius was not sure what the symbols said; but after considerable thought he decided that they meant: 'We are ready to lay down our weapons [the arrows], to give you our land [the mouse] and our water [the frog], and to fly [the bird] from your legions.'

Darius proclaimed the surrender to his warriors, who began a celebration. That night, believing the enemy had fled, the Persians were attacked and beaten by the Scythian army. The Scythian commander, so the story goes, explained the true meaning of his message. 'We warned you', he said, 'that unless you could turn yourselves into birds and fly away, or into mice and burrow under the

ground, or into frogs and hide in the swamps, you would never escape death from our arrows.'

Another rendering of this story, probably closer to the truth, says that the symbols were delivered to Darius, who showed them to one of his counsellors, and that the counsellor correctly explained their meaning—but Darius chose to ignore the warning and the Scythians won the battle.

Darius the Great won fame in another fashion. Proud of his accomplishments, he had his men carve the story of his conquest on the limestone face of a rugged mountain some five hundred feet above the village of Behistun in what is now western Iran. Since Darius ruled the Persians, the Elamites, and the Babylonians, it was customary for him to issue any proclamations or decrees in three different kinds of writing, so that the people of the three nations could understand them. Accordingly the Behistun carvings were done in these three cuneiform systems. The symbols totalled 413 lines and were accompanied by several carved human figures, including one of Darius himself with his foot on the body of a conquered enemy. The inscriptions were at least eleven feet high.

Like the hieroglyphs, all cuneiform writing was a mystery—and it was King Darius's carved tribute to himself that was to help solve the cuneiform puzzle some two thousand years after his death. In the 1830's Sir Henry Rawlinson copied and published the Behistun inscriptions, declaring them to be three versions of the same mysterious text; in 1846 he completed a translation of the Persian cuneiform symbols. This simplified the reading of the two remaining sections of cuneiform writing and made it possible for scholars to decipher other, more ancient, cuneiform stones and tablets. Great care was necessary to be sure that the right meaning was attributed to the various symbols, to avoid the confusion that has already been mentioned.

This confusion had kept the cuneiform writing from

becoming popular. When other peoples, such as the Greeks and Phoenicians, began to use it, they found it to be unsuited to their kind of language. Some of their words consisted of several syllables and were very long and cumbersome when written in cuneiform, so they developed a more practical system of their own—a system which was the real beginning of our alphabet as we know it today.

Few of us realize that in our own modern era a great many signs and symbols play important parts in our daily lives. Besides red and green traffic lights, we have traffic signs of different shapes; and although some carry words, such as STOP, others have merely two lines like a T to denote an intersection, or a heavy S-shaped line to warn of a curve in the road ahead.

Flags are used as a means of identity by all nations.

The revolving barber's pole, with its red and white spiral stripes, shows where we can get a haircut or a shampoo.

We recognize advertisements for well-known products by familiar designs.

From distinctive uniforms and insignia we can identify a policeman, a soldier, a sailor, a marine, or a boy scout, just as kings and knights and warriors of the Middle Ages wore crests or emblems upon their shields and armour to identify themselves or show their allegiance.

In that feudal age these emblems were highly important, because they made it possible for the knights and soldiers in hand-to-hand clashes to recognize their allies quickly, and for this reason the emblems were usually in bright colours. In heraldry the colours are still called by their Norman-French names—*azure* (blue), *gules* (red), *vert* (green), *sable* (black), *purpure* (purple), *or* (gold), and *argent* (silver).

In the fourteenth century coats of arms were placed on tombs; at the gates of the great castles and on smaller manors; on locks; on weather-vanes; on windows, chimneys, and furniture. They appeared on the clothing

of the nobles and of their wives, children, and servants; on the trappings of horses; even on the leather hoods used to cover the heads of falcons and hawks.

In our daily lives we still have to interpret various symbols and signs when we read books, magazines, or newspapers. In some books, for example, you see and understand these signs:

‘ ? : ’ — ( ) * & % £ ; = + ! , .

Some of these can be traced back to certain words—like *questio*, Latin for ‘question’. The ancients abbreviated the word to *qo* and later topped the ‘o’ with the ‘q’ $\binom{\text{q}}{\text{o}}$, and the gradual distortion of this combination gave us our question mark (?).

The fact is that *every letter that makes up every word we read is nothing more nor less than a sign or symbol that stands for a sound.* Our words are merely our own form of hieroglyphs —and we can actually trace back to some ancient picture almost all of the letters that make up what we call our alphabet.

3

ABCDEFGHIJKLMNOPQR STUVWXYZ

Our word 'alphabet' comes from the ancient Phoenician letters *aleph* and *beth*, from which came the Greek words *alpha* and *beta*.

Scholars assume that our alphabet originated with the Phoenicians, from whom it was taken over and developed by the ancient Hebrews. Both of these peoples, however, were among the so-called Semitic tribes, which also included the Arabs, Syrians, and Assyrians—all supposedly descended from Shem, son of Noah. It seems safe to say that our alphabet is of Semitic origin; and most authorities give the credit to the Phoenicians, once known as Canaanites.

Some of the oldest known Semitic writing was carved on a large black stone about 850 B.C., upon orders from King Mesha of Moab, mentioned in the Bible, and tells about his battles with Israel. The Moabite Stone was lost and forgotten until about 1868, when it was discovered by a German missionary at Dibon.

He made an impression of the stone, intending to move it later. From his actions, however, the Arabs realized that it might be of value to Christians; so they built a fire around it and then plunged it into cold water, causing it to break into forty pieces. The Arabs proposed to get more money for it by selling the pieces, though small chunks were parcelled out to various Arab families as charms and souvenirs. The larger fragments were recovered by a Frenchman, pieced together, and are now on exhibition in the Louvre in Paris.

I examined a replica of the stone now in the Smithsonian Institution in Washington. It is forty-four and a half inches high, twenty-six and a half inches wide, and fourteen inches thick, and it carries thirty-four lines of symbols.

The picture symbols on the Moabite Stone were not as difficult to decipher as the hieroglyphs or the cuneiform writing, because they were very similar to the letters used by the Phoenicians, the Hebrews, and the Greeks, leading the experts to believe that the Greek alphabet was based upon the ancient Semitic carvings. Herodotus, the Greek historian, wrote that 'the Phoenicians introduced into Greece the knowledge of letters, of which, as it seems to me, the Greeks had heretofore been ignorant'.

Some of the Semitic symbols, in turn, were perhaps derived from the older Egyptian or Sumerian picture symbols; but whereas most of the hieroglyphs represented pictures of ideas or things, and a few sounds, the Semitic people used symbols to indicate *only* sounds that could be put together to make words.

Thus the first Phoenician-Hebrew letter, *aleph*—which became the Greek alpha (α)—may have derived from a Babylonian character representing the head of an ox; for *aleph* means 'ox' in Phoenician and Hebrew. But that is all we know about the origin of the Semitic alphabet, except that it seems to be some 3,000 years old.

This alphabet had a total of twenty-two symbols for the same number of different sounds, nearly all of them consonants; therefore people who read the words out had to insert vowels as they spoke. As an example, the word for 'water' was *mem*; but there was no letter 'e', so that the word looked like this: 'm-m'. The speaker or reader would supply the missing 'e' to complete the word. In a way this was like writing modern abbreviated forms (rd, ft, cwt, Ltd, Mddx, bldg, yrs, etc.).

The Phoenicians carried on an active trade with other peoples, especially the Greeks, and in their day-to-day business the use of written records became increasingly

important. The Semitic alphabet of consonants seemed satisfactory to the Phoenicians; but the Greeks found it awkward because of the lack of vowel sounds, so they took the obvious step—they adopted nineteen letters of the Phoenician alphabet, changed part of it to provide the vowels they needed, and added a few new characters, and finished up with a total of twenty-four alphabetical letters.

Here is a list that shows at a glance the nineteen borrowed Semitic originals and the Greek designations and additions:

Semitic	*Sound*	*Greek*	
Aleph	A (guttural)	Alpha	α
Beth	B	Beta	β
Gimel	G	Gamma	γ
Daleth	D	Delta	δ
He	H	Epsilon	ϵ
Zayin	Z	Zeta	ζ
Cheth	CH	Eta	η
Teth	TH	Theta	θ
Yod	Y	Iota	ι
Kaph	K	Kappa	κ
Lamed	L	Lambda	λ
Mem	M	Mu	μ
Nun	N	Nu	ν
Sameth	S	Xi	ξ
‘Ayin	A (short)	Omicron	ο
Pe	P	Pi	π
Resh	R	Rho	ρ
Shin	SH	Sigma	σ
Tav	T	Tau	τ
		Upsilon	υ
		Phi	φ
		Chi	χ
		Psi	ψ
		Omega	ω

Gradually the Greeks began to change the shapes of most of the symbols.

Daleth, the Semitic symbol for D, was actually shaped like a triangle. The Greeks retained this character, which they called *Delta*; and in later ages the Romans curved the sharp angle at one side, producing our letter D.

In similar fashion the shapes of some other symbols were changed through the centuries. Scholars who struggled to decipher the hieroglyphs, the cuneiform, and the early Greek symbols solved a part of their problem when they discovered that much of the writing was from right to left, and some went both ways! One line would be written from right to left, the next from left to right, and so on throughout the inscription, just the way a farmer might plough a field. This method, in fact, was called *boustrophedon*, meaning 'ox-ploughing'. Sometimes the symbols were even carved in vertical columns, which indicates that the shape of the writing surface evidently dictated the way the inscriptions would be made. Finally, about five hundred years before Christ, the Greeks decided to record their letters and words from left to right only, as we do today. Some languages, such as Hebrew, are still written from right to left, and some oriental languages, like Chinese and Japanese, are vertical.

The trail of our alphabet shows that a mysterious ancient land called Etruria, home of the Etruscans, apparently played a major role in bringing the Greek letters to the Romans. Even with all our modern explorations, scientific discoveries, and knowledge, we probably know less about the early Etruscans than about any other ancient people. Archaeologists have found ruins of Etruscan buildings, a lot of Etruscan pottery, jewellery, and other relics, including stones and monuments bearing words carved in the Etruscan language—but despite many years of study they have failed to decipher more than a few hundred words.

At least seven hundred years before Christ, Etruria

formed part of what is now central Italy and may have included part of Rome. As the Roman Empire grew and became more powerful, its armies overran the Etruscans and swallowed up Etruria.

In their reign the Etruscans used an alphabet based upon the early Greek symbols—probably acquired from the Greeks in Asia Minor, the peninsula between the Black Sea and the Mediterranean. In addition, however, there were pure Etruscan letters and words, and these are the characters which now make deciphering so difficult.

Because the lives of the Etruscans and Romans were so intermingled, and since the Greeks occupied the southern part of Italy, it is easy to understand that the Greek alphabet had a tremendous influence upon the writings of the Romans. Just as the Greeks changed the Semitic letters to suit their own tongue and purposes, so the Romans made changes in the Greek symbols until they finally settled upon a total of twenty-three, which they recorded in this order:

A B C/G D E F H I K L M N O P Q R S T V/Y X Z

As the Roman legions swept through many lands in their age of conquest, their alphabet and their language (Latin) spread among many peoples. Later, when it became the language of the Roman Catholic Church, Latin was taught to many by priests and used in the churches and monasteries.

Consider the story of a boy named Sucat, born in A.D. 389 in England, son of a deacon named Calpurnius. When Sucat was only sixteen years old he was captured by the marauders of an Irish king and delivered into the hands of an Irish chieftain, who made the boy his slave and set him to tending sheep in the mountains. After six years in bondage, Sucat, a devout Christian, escaped and went to France to study for the priesthood. In 432 he was consecrated a bishop and sent forth by the Pope to teach

love and mercy and kindness to the people of Ireland—the rough, wild, unruly heathens to whom robbing, fighting, and killing represented a way of life.

Sucat managed to carry the Word of God to more and more people. History points out that Sucat was almost illiterate, an accusation whose truth he admitted in his writings, and this is not surprising because very few people in that day were skilled in the arts of writing and reading. The fact is that he did know the Roman alphabet and much of the language of the Church, and it was the bringing of this alphabet and of Latin to Ireland, as well as the spreading of the Gospel, that won him an important place in religious history.

So pleased was the Pope with Sucat's work that he bestowed upon him the name 'Patricius', which is Latin for 'noble'. From that title came the name by which all Christians know Sucat today—for he was St Patrick, the patron saint of Ireland.

During the fifth century the Roman legions were cut down by savage hordes from Asia, from Germany, from the unknown countries of the north, all bringing with them new and strange words and writings. These naturally became mixed with the Latin speech and writings of the Romans, producing the languages of modern Europe. Even today the Latin base of many words can be easily detected in French, Spanish, Italian, English, and other languages.

Another letter was yet to find its way into our alphabet—the letter W. The Romans had no word in which the sound of W was used, so they never created it. One story says that some seven hundred years after Christ a wandering story-teller travelled through the English countryside collecting pennies from the good folk who listened as he told the tale of Beowulf, the dragon slayer. A friar, hearing the story, tried to write it down but knew no letter in Latin for the sound of W in 'Beowulf', so he took the sound of the first letter in the Saxon word 'wenn'. Other sources

say that the letter was formed by Norman scribes who represented the sound of the English W by writing a double U (UU)—or a double V (VV), which served as either V or U—and that this combination was eventually compressed into the single letter we use today.

During the fifteenth century another letter was added to the alphabet. At that time it was customary to make a fancy 'I' whenever this letter was used as a capital at the beginning of a sentence. Instead of a straight vertical stroke, the ornamental 'I' was given an upward curl to the left so that it resembled our present capital J. When written in that way, the 'I' was originally given a sound like the 'y' in *yacht*; but this gradually developed into 'dee-yuh' and finally into 'dzh', or the J sound we use today—and it became our letter J. When used within a word, the 'I' carried its original pronunciation.

Before the adoption of the J, the same sound was represented by the letter 'g' in words such as 'gesture', 'geometry', and 'genius'. Even today, in some instances when the letters of the alphabet are used to designate a series of some kind, we may find that the J has been omitted.

Almost as important as the letters of the alphabet were numerals to represent quantities—numbers of people, or cows, or sheep, or pieces of gold, or ships, or bushels of grain, or days, or years, or other things counted. The Phoenicians and the Greeks used their alphabets for numerals, and a need for more numbers than they had letters actually brought about some additions to the Greek alphabet.

The first men on earth probably used their fingers to indicate simple numbers. A cave man might rush home from a scouting trip, put his hands on the sides of his head and stick up two fingers to imitate the horns of a deer, then lower his hands and hold up three fingers on one hand, thus reporting that he had seen three deer.

This system of counting on the hands was carried down through the ages and is the reason why most nations count by tens today. When it became necessary to *write* or carve symbols for numbers, the obvious method was to copy the hand; that is, to make one mark representing one finger, two for two fingers, and so on up to and including nine. (Note that the word 'digit' has two different meanings: 'finger' or 'toe', and 'any of the figures from 1 to 9'.) As yet the nought had not been invented, and 10 was usually given a special symbol.

The earliest numerals yet discovered can be traced to the Egyptian hieroglyphs dating from about 3400 B.C., and consisting of short vertical lines for numbers from 1 to 9, with a figure resembling an upside-down capital U for 10. Strokes preceding the inverted U were added to the 10; for example, 11∩ represented 12. For 100 the Egyptians used a symbol somewhat similar to our present number 9.

The Chinese and other Far Eastern peoples used horizontal instead of vertical strokes, one above the other.

The Sumerians followed the Egyptian pattern except that their strokes were cuneiform, or wedge-shaped, instead of straight lines, and their symbol for 10 was either a chevron (pointing left) or a plain dot. For 100 they used a vertical wedge and to its right centre a horizontal wedge (pointing right).

The Jews, although they patterned their alphabet after the hieroglyphs, evolved their own idea for numerals. It consisted merely in making each letter represent a number. A, for *aleph*, was 1; B, for *beth*, was 2; C was 3, and so on up to 9. As we have seen, the Jews had only twenty-two letters in their alphabet, and after using the first nine for numbers 1 to 9 they had thirteen letters remaining to be used for larger numbers. Accordingly they assigned the next nine letters to represent tens—10, 20, 30, 40, etc.—and this left four letters, which they set up as

hundreds. In other words, their arrangement was like this:

First nine letters:	1	2	3	4	5	6	7	8	9
Second nine letters:	10	20	30	40	50	60	70	80	90
Last four letters:	100	200	300	400					

This meant that they could count from 1 to 499 before they had to begin again at 500.

The early Greeks used primitive numerical systems; but during the third century B.C., just as they had 'borrowed' the Hebrew alphabet and modified it to suit their own needs, they also adopted the Hebrew numbering plan, using the Greek alphabet to represent the numerals. The Greeks, however, decided to set up three sets of nine letters each:

First set:	1 to 9
Second set:	10 to 90
Third set:	100 to 900

To do this they needed an alphabet of twenty-seven letters; theirs had only twenty-four, so they added three more letters. One was the Hebrew *vav*, which they shaped like our letter F; one was the Hebrew *qoph*, similar to our Q; the third was a new symbol that looked like this: ϡ.

The *vav*, or F symbol, was inserted in the sixth position in the alphabet and given the value of 6. The *qoph*, or Q, was put in the eighteenth position (end of the second nine letters) and represented 90; and the new symbol was put in the last, or twenty-seventh, place and designated 900.

A straight line, or comma, placed before a letter meant that the corresponding number was multiplied by 1,000:

,α.

A letter placed over the letter M (for *myriad*) signified tens of thousands:

$$\overset{\beta}{\mathrm{M}} = 20{,}000$$

The Greek method was more efficient than the methods preceding it, but people who used it had to memorize at least twenty-seven different symbols. The next step in simplification came from the Romans.

As you know, the Roman numerals from 1 to 10 are written like this:

I II III IV (or IIII) V VI VII VIII IX X

There are various theories about the origins of some of these symbols. One is that the numeral V, or 5, is a picture symbol of the V formed by the thumb and first finger when the hand is open, fingers together and the thumb extended, representing five digits. The X, or 10, was simply two V's.

Another theory holds that the V, or 5, came from the method of tallying which some of us use even today. We make a straight vertical line for each item, but for every fifth tally we draw a diagonal line through the first four, like this: ~~IIII~~. Now, if you eliminate the first three straight lines, leaving the diagonal and the fourth tally mark, you have a V, representing 5.

For some obscure reason the Romans chose L to represent 50. For 100 they selected C (for *centum*, meaning 'hundred'), and for 1,000 they used M (for *mille*, meaning 'thousand'). At a later date a horizontal line above the M ($\overline{\mathrm{M}}$) signified 1,000,000, and D, for 500, was introduced.

The great advantage of the Roman system over the Greek and others was that its users had to remember only the symbols: I, V, X, L, C, and M.

The Roman numerals gained wide use; and even now they are often placed on modern clock faces, on formal

documents, and are sometimes chiselled into the corner-stones of new buildings to show the year of construction.

In practice, in everyday commerce, the Roman numbering system presented one tremendous difficulty. It could not be used easily or readily to make fast calculations—to add, subtract, multiply, and divide. Such processes were slow and cumbersome. How would you go about doing this multiplication problem:

MCLXVII × CCCLXXVIII = ?

Only experts could work out such mathematical problems. Business men who were not so qualified had to use some simpler system, so they used boards with slots that would hold five pebbles per slot. These were probably the first wooden adding machines. By filling the slots, or by removing the stones, the user could do simple addition or subtraction without too much difficulty, although multiplication and division required considerable time and care. This device later led to the development of the counting board, or *abacus*, which was used for centuries to 'calculate' (from the Latin *calculus*, meaning 'pebble') and which is still used in some Asiatic countries.

This brings us down to the system we use today, employing what we call the Arabic numerals.

The term 'Arabic' implies that our numerals originated with the Arabs, but extensive research shows that most of the figures so familiar to us (1 2 3 4 5 6 7 8 9) were created and used by the Hindus in India not later than the third century B.C. Evidence also indicates that the Arabs and Persians had some influence in the formation of the numerals, so it might be more accurate to call them 'Hindu-Arabic-Persian' numerals.

In 1896 archaeologists in Nepal discovered an ancient carved inscription of King Aśoka, Buddhist emperor who reigned in India about the middle of the third century B.C. The carving tells how Aśoka came to worship in the

grove of Lumbini (where the inscription was found), because this was the place where the Buddha was born. Among the symbols used to record the tale were figures resembling some of our numerals, though how they came to be designed in this manner no one really knows.

Another carving, dated about a hundred years later and found in a place called Nānā Ghāt, also in India, included the figures 2, 4, 6, 7, and 9. The 3 and the 5, along with the others, appeared in Hindu carvings found in many Buddhist caves in the district of Nasik, in Bombay; and although the carvings covered the period from the third century B.C. to about A.D. 600, the 3 and 5 were traced to about the first or second century after Christ.

While the numerals were not exactly like those we now use, they resembled them. One interesting observation indicates that the figures 2 and 3 grew from the oriental double and triple horizontal strokes as *cursive writing* developed. (In cursive writing the letters are joined together. Handwriting is cursive writing.) With very little imagination it is easy to see how the horizontal marks for 2 and 3 ($=$ $\equiv$) were joined to produce the now-familiar designs for these numerals.

In the trade and commerce carried on by the Hindus with the Arabs, Persians, and other nationalities, the Hindu numbers were adopted, after centuries, by these other traders with some distortion. By the eighth century A.D. the Arabs especially found the numerals useful in their progressive studies of mathematics, including the system they invented and called *al-jebr* (Arabic for 're-union of broken parts'). We call it *algebra.*

Historical records indicate that Arabic numerals were not used in Europe until *c.* A.D. 1000.

To the Arabs must go the credit for a giant step in the science of numbers. They gave a 'place value' to their figures; that is, they decided that one numeral by itself would represent its own value, from 1 to 9; two numerals

would signify a counting by tens, from 10 to 90 (for example, 12 would be 10 plus 2); three would indicate hundreds, four would be thousands, and so on up the scale. In this way, instead of having to write the alphabetical symbols for 100, 20, and 3 to denote one hundred and twenty-three, as the Greek system would require, the Arabs would write 123 as we do today, the value of each number depending upon its position in the whole.

To use this system properly they required the use of a zero. There is reason to think that the Hindus may have used zero in their inscriptions before the ninth century A.D., giving it the Sanskrit name *śūnya*, meaning 'void', but it appears that they used it only for a calendar symbol and not for mathematical calculations. When the zero was taken over by the Arabs they called it *śśifr*, from which we get the term 'cipher'. In later years the Italians called it *zevero*, which became the English 'zero'.

The zero served two vitally important purposes. First, it made the 'place value' system workable. Under that system, if the Arabs wanted to write numbers for one hundred and one, it would look more like eleven unless they left a space between the numbers (1 1) or used some symbol for the middle position. The zero had no value of itself, so it was a perfect device for this mission. Its second purpose was to show that a given number subtracted from itself left nothing—zero.

As the peoples of the world increased and spread out and intermingled, so did their manner of speaking and writing and calculating. More than two hundred alphabets are known, and about fifty are in actual use throughout the world.

When men first devised written symbols they had to record them by chiselling in stone or by cutting them into clay tablets and baking the tablets, or by scratching them on the bones of animals. With progress came the need for finding writing materials that were easier to get, to use, and to carry.

4

THE PAPER-MAKERS

Long ago the words of the Bible were laboriously written on palm leaves by scribes who had no better writing surface. Ancient peoples often used the leaves of trees for making certain inscriptions, and it is probably because of this practice that we call the page of a book a 'leaf'.

In addition to stones and bones and pieces of clay, the early civilizations wrote on oyster shells, ivory, and tree bark. In the British Museum in London is an original letter written on a piece of bark about six feet long, richly ornamented in gold. The early Romans used the very thin peel that grows on the inner side of the bark, between the bark and the wood itself. This they called *liber*—from which came the Latin word for 'book', as well as our word 'library'.

In the Book of Job, in the Bible, we read about writing on stone, rocks, and sheets of lead. Lead, being soft, could be rolled up and carried with little difficulty. Several bronze tablets bearing Etruscan symbols have been unearthed in Tuscany. Treaties among the Romans, Spartans, and Jews were inscribed on brass, and excavations in India have uncovered writings cut or etched into copper plates.

Ancient shepherds used thorns and awls to scratch songs on leather straps which they wound around their staffs. One Icelandic hero, skilful with a knife, cut the

story of his adventures into the wood of the bed and chairs in his home! The laws of some of the Roman rulers were carved on slabs of cedar, because the oil of cedar was known to be a preservative that would keep the wood and inscriptions intact for long periods.

There were several drawbacks in the use of all of these writing surfaces. Stone, clay, and wood were heavy and took up a great deal of storage space. Tree leaves were perishable. Bones made writing awkward. And all of these materials made it virtually impossible for a scribe to make corrections or changes, once he had actually recorded a symbol or word.

The early Romans were probably the first to remedy this last difficulty by coating flat pieces of wood with wax and then cutting their inscriptions into the wax. If changes were necessary it was a simple matter to 'erase' a letter or word or sentence by smoothing over the wax, much as we would spread soft butter on a slice of bread, and then write the revision on the smoothed portion. A message could be cut into the wax and sent to a person in another town, who could read it, smooth it over, and write his reply on the same waxed board. In some instances the Romans surrounded the board with a frame for protective purposes, and fastened several of the boards together with leather thongs, like pages in a book.

The ancient Egyptians, however, were far ahead of other peoples (except the Chinese) in developing more efficient writing surfaces; for we know that at least two thousand years before Christ they were making inscriptions on a thin, light, flexible material called *papyrus*, which was almost like paper.

Papyrus is a water plant, a reed of the sedge family. When fully grown it has a main root which is often fifteen feet long and as thick as a man's arm. There are short pointed leaves around the base; but the reed itself is leafless except for a rather bushy blossom sprawling out at the very top, and may be anywhere from six to ten

feet high. The 'bulrushes', in which the Bible tells us the baby Moses was hidden, were actually papyri.

Since the papyrus grew profusely in the shallow waters of the Nile, the Egyptians experimented with the plant and found it to be of extensive practical use. The dried roots made excellent fuel for their fires. The fibres of the long thick stem were woven into sails, mats, cloth—even coated with a gummy resin and fashioned into light boats. The pith, or heart, of the reed was good to eat, raw, baked, or boiled. Truly the papyrus was a complete general store to the Egyptians, but one of its greatest values was its suitability for the manufacture of writing material.

To transform the plant into a flat sheet the Egyptians cut long narrow strips from the stem of the reed and laid them close together, side by side, to whatever width was desired. When the strips had been laid out they were interwoven with a layer of shorter strips placed crosswise, and the woven sheet was then soaked in the waters of the Nile. While wet it was pounded gently, probably between two stones, and the pounding served to mesh the two layers of strips together, forming a solid surface. It was then dried in the sun and rubbed with a shell or a smooth rock to remove any rough places. The finished 'sheets' were anywhere from six by nine to nine by fifteen inches in size and it was customary to paste them together at the edges to make strips as long as thirty feet, though some are known to have been over a hundred feet in length!

A strip was rolled on two round sticks to make a scroll which could be unwound from one stick and read as it was slowly rolled up on the other. The Romans called the scroll *volumen*, from which comes the English word *volume*. In schools and assemblies today we often 'call the roll'.

Papyrus was not long used exclusively in Egypt; for once again the Phoenicians recognized a good thing when they saw it, and they knew that papyrus could be profitable as well as useful. The Phoenicians began to buy the

papyrus rolls from the Egyptians, who were happy to discover this new source of income, and the Phoenicians not only used the material for their own writing but also found a ready market for the product in the city of Byblos, the capital of their country. Later the Greeks began to buy supplies of papyrus from the merchants of Byblos, and subsequently the Greeks used the name of this city as the basis for their word for 'book', which was *biblos*. To this source we can also trace our word 'bible'.

So heavily in demand was the papyrus, both for the necessities of life and for writing material, that the reed began to be in short supply, and King Ptolemy V, about 200 B.C., issued a decree prohibiting the export of papyrus from Egypt. This, of course, ruined the papyrus trade that had been built up by the Greeks, and started a frantic search for a good substitute.

Tree bark had already been tried, but the right kind was not always available and it would not stand rough handling. Some of the Greeks used the skins of serpents to good advantage, and it is said that the *Iliad* and the *Odyssey* were once written on snakeskin.

In Pergamum, in Asia Minor, King Eumenes II took an interest in the problem and set his people on a quest for a smooth, light, durable writing surface. Among the suggestions that resulted was one for using animal skins. Skins had been used infrequently for many years for writing purposes; but they were usually rough, hairy, or otherwise inferior to papyrus, and at best could be used only on one side. King Eumenes, however, was shown how the hides of sheep, goats, and calves could be bleached and rubbed with pumice stone so that they would be soft and smooth enough to tak
sides. They could be folded, and they
than papyrus. The king was pleased,
people begin the business of prepa
papyrus substitute.

The substitute found great favour with the Greeks, Romans, and others who had been deprived of the papyrus. Treated with bleach or dye, some of the skins were white, some yellow, some purple. Purple was most popular with the Romans, who said that the white was too dazzling to the eye and too readily soiled, and they produced some of the most beautiful of all ancient manuscripts by writing on the purple skins with letters of gold and silver.

At first the Romans called the skins *membrana*, referring to the membranes of the animals; but the later and more general term was *pergamentum*, from Pergamum, where the improved processing had originated, and from *pergamentum* came our word 'parchment'.

While the Egyptians and Greeks and Romans were writing on papyrus and parchment, another ancient people, the Chinese, had discovered a secret which was to revolutionize the writing business, to surpass all other materials for ease and convenience in writing, and to create a huge industry that has lasted to our own time. The Chinese learned to make paper.

The world's very first paper manufacturer was probably the wasp. Although some of the ten thousand species of this buzzing, stinging insect make their homes in the ground or by tunnelling into wood, others actually make paper which they use to build their houses. The wasp chews bits of wood into a pulp, mixing it with a mouth secretion, and fashions the pulp into a very thin mass which, when it dries, becomes paper.

The wasp may or may not have inspired the making of man-made paper. The first manufactured paper was made about A.D. 105 by a Chinese named Ts'ai Lun, who was in charge of the household of the Emperor Ho Ti. Up to that time the Chinese had used silk or strips of bamboo as writing surfaces; but the bamboo was not satisfactory, silk was very costly, and the emperor sought a better, more convenient material. Ts'ai Lun's paper was made by the same process as that in the wasp's nest; that

is, Ts'ai Lun gathered bark, probably from the mulberry tree, pounded or ground it into a watery pulp, strained it through screens made of bamboo, pressed it out into sheets, and let it dry. For his discovery Ts'ai Lun was made a noble by the emperor, and after he died a temple was erected to his memory.

Later experiments showed that paper could also be made from fibres other than tree bark, including hemp, flax, and some kinds of grass.

Since travel between China and Europe was infrequent and incredibly slow, paper was not known outside China for some five hundred years. Paper provided an excellent means for the Buddhist priest-scribes to spread their faith among the Chinese and Japanese, and it was used extensively for this missionary work.

The Chinese kept their process a heavily guarded secret; but wherever paper was used there was a growing demand for it, even though it was very expensive. Because the market was excellent the Chinese wanted to make the most of their profitable business, but in order to carry the product to the buyers they had to spend many months travelling by snail-paced caravans. For a more efficient operation they decided to set up a paper-making plant in Chinese Turkestan (now called Sinkiang)—close to the Moslem countries, which were good customers. This move was destined to destroy the Chinese monopoly of paper manufacture.

There are at least two versions of this development. One is that the traders of Bagdad, the focal point for caravans to the East and West, bribed, threatened, or beat the Chinese until they revealed the secret. The other is that the Chinese about A.D. 751 attacked the Arabs who occupied Samarkand, once the capital city of Tamerlane, the Mongol prince. The Arabs repulsed the attack, and in the course of the battles captured certain Chinese prisoners who knew how to make paper and who revealed the secret to the Arabs, no doubt to save their own lives.

Whatever the true story may be, it seems that the Arabs soon began to manufacture paper from flax and to put it into use throughout the Moslem empire.

For a long time the Arabs confined the manufacture and use of paper to their own domain; but in the middle of the eleventh century the Moors established paper-mills in Spain. It is probable that the first paper-mill in any Christian country was built at Fabriano, Italy, where fine hand-made paper is still being produced.

Slowly the art of paper-making travelled north. Paper was used in England during the fourteenth century, but no one is quite sure when the actual manufacture of paper began here. It may have started during the fifteenth century, and records indicate that paper-mills were established in Hertford by John Tate and in Dartford by Sir John Spielman in the sixteenth century.

In these and other mills the paper was made by hand, one piece at a time, until a Frenchman named Nicholas Louis-Robert, an employee of the Didot family at a paper-mill in Essonne, France, invented a crude machine on which the pulp could be poured and pressed to produce a continuous roll. An improved version of this machine was set up at Boxmoor, Hertfordshire, in 1799; it is still regarded as the ancestor of all modern paper-making machines.

In some Christian countries paper could not be used for the writing of government documents or important official communications for several centuries because the Church opposed its use on the grounds that it was of Moslem or Buddhist origin and therefore not suited to Christian purposes. In these areas parchment continued to be used for important writings; but as the supply of parchment grew smaller and smaller, the restrictions were gradually lifted and paper replaced it.

In Egypt, home of the papyrus, paper was first used around A.D. 800. Although it was recognized as being superior to papyrus and much less expensive, it was some

fifty years before paper was in wide use by the Egyptians, and another fifty years before it had made papyrus virtually obsolete. One reminder of that material is still with us, however. Our word 'paper' is derived from the name of the plant which was paper's ancestor—the papyrus.

In its spread throughout Europe the art of paper-making became known to craftsmen who set out for America, taking their knowledge and skills with them. One of these was William Rittenhouse, born in 1644 in Rhenish Prussia. Rittenhouse, a Mennonite minister, was in the paper-making business with his brother in the Netherlands when, in 1688, he decided to take his family across the ocean to the new land.

Rittenhouse settled in Germantown (now Philadelphia), Pennsylvania, organized a company, bought twenty acres of land on Wissahickon Creek, and in 1690 built what was undoubtedly the first paper-mill in the United States.

Today, whether paper is made by hand or by modern machinery, the basic process is still the same as that used by the ancient Chinese. Wood or cloth (or a mixture of the two) is converted into wet pulp, drained, pressed, and dried to become paper. One additional step has been added—our modern writing papers or bond papers are 'sized': that is, after the pulp is dried into sheets, the paper is coated with a thin solution of glue or starch (called 'sizing'), and it is this coating which keeps ink from smearing or spreading when it touches the sheet.

Where old Ts'ai Lun and his emperor considered it an achievement to produce one kind of paper (and it *was* an achievement), today we have some five thousand different kinds. In addition to our fine writing papers we have soft tissue, wrapping paper, cardboard, roofing paper, construction paper, drawing paper, many kinds of printing paper, and building board, all in many grades.

Paper, parchment, papyrus, tree bark, snakeskin, slabs of wood, and waxed boards were easier than stone and clay to write upon, and they could be carried from place

to place without too much difficulty. Sharpened flint and iron chisels were needed to carve the messages into stone, but flint and chisels were of little use for writing on papyrus or parchment or paper.

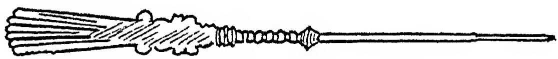
What, then, did men use for such writing?

5

FROM STYLUS TO TYPEWRITER

To REDUCE the number of murders and stabbings among their people, the Romans finally outlawed one of the oldest of all writing instruments—the metal *stylus*.

The stylus came into use when the ancients developed the wax-covered wooden tablet. This writing tool was perhaps six or seven inches long, with an ornamental handle attached to a skewer-like spike with a sharp point.

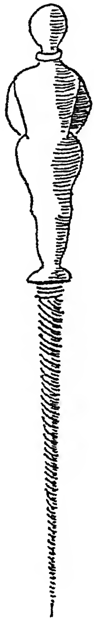


Roman stylus

It was ideally suited to writing on the wax. The point easily scratched its way through the coating and 'erasures' were made with the handle, which was sometimes flat, sometimes topped with a sphere or cone. In either case the handle was used to smooth out mistakes and make a new writing surface.

Used as a dagger, the stylus was the fatal weapon in many killings. Roman students apparently included some juvenile delinquents, for there is at least one case on record in which a schoolmaster was stabbed with styli wielded by several rebellious members of his class.

The waxed boards, called *pugillares*, or table-books, were sometimes heavy enough to be swung as effectively as clubs, and Plautus, a famous Roman writer, tells of one angry schoolboy who banged his teacher's head with his homework!



Stylus with human-shaped handle

Since the stylus was an important writing instrument, the authorities ruled that scholars and others could use a substitute for the metal; so they designed and made styli from the bones of birds or other small creatures, or carved them from ivory—devices that were strong enough to scratch the wax but too fragile to make effective murder weapons.

The waxed tablets continued in use long after papyrus

appeared; but as they gradually gave way to the papyrus, the stylus was supplanted by a new writing tool—a sharpened reed, ancestor of our modern pen. The reed used by the Egyptians for this purpose was the *calamus*, a vine that grows to a length of five hundred feet and has a hollow stem somewhat thinner than an ordinary modern lead pencil. To a lesser extent, bamboo shoots were also made into writing instruments.

The processing of the reeds or bamboo was very simple. At first the Egyptians merely cut several slits in one end of the stem, making a crude kind of brush. When dipped into ink and touched to the papyrus, this made a rather broad stroke; so in time they improved the method by making a diagonal cut towards one end of the reed, slicing off enough of it to form a sharp point. They cut a slit lengthwise through the centre of this point to help to hold the ink, a feature that we still see in our present-day metal pens.

Our word 'ink' comes from the Latin *encaustum*, meaning 'burnt in'. The ink first used by the Chinese and the Egyptians was a solution of lampblack, or common soot, in water, with the addition of some kind of gum or resin that gave it body. The Egyptians also discovered how to make ink with gall-nuts, sometimes called oak apples. A gall-nut is a lump or ball-like growth that forms on the leaf or stem of an oak tree when an insect known as the gall-fly lays its eggs on the stem or leaf. When crushed and mixed with a solution of iron, the gall-nut makes a good black ink.

The Romans and Greeks found a ready-made source of ink in the sea. The cuttlefish, which resembles a squid, has an 'ink' sac from which it expels a dark fluid when it is frightened or about to be attacked, thus confusing its enemies. The Greeks and Romans caught cuttlefish, removed the ink sac, and did their writing with this dark brown fluid, from which we later obtained the colour we call sepia.

Red, blue, green, and even gold and silver inks were used to make some of the most beautiful hand-written book pages the world has ever seen.

A simple 'invisible ink', once used by spies, is ordinary lemon juice or sweet milk. A message written with these liquids cannot be read until the paper is heated (it may be held close to a glowing electric light bulb), when the 'ink' will turn brown.

The goose-quill pen

The next major improvement in writing instruments was the quill, a feather taken from the wing of a large bird—usually a goose, although writing quills were also taken from eagles, owls, turkeys, swans, and crows. (Modern stationery or artists' supply stores sell small, narrow, flexible steel pen-points called 'crow-quills', used for making very fine lines.) In fact, our word 'pen' comes from the Latin *penna*, meaning 'feather'.

Wing feathers from the swan made better quills than those from the goose, but swans were not plentiful and geese, or turkeys, were easy to raise. Huge flocks were scattered throughout Russia, Germany, Poland, and Holland after the quill became popular in the sixth century. Only six feathers from each bird were suitable

for the making of writing instruments, although some of the inferior smaller plumage was occasionally sold to make a product of poor quality. The feathers were not simply plucked from the birds and put into use. They were graded by length and thickness and then, because they were covered with a membrane, they were usually baked in hot sand or otherwise heated. The warmth made the membrane shrivel up, so it could easily be wiped off the feather, which was then dipped in a solution of alum or acid that made the stem as hard as a modern plastic tube. The treated quills were tied in bundles, ready for the market.

People who bought the quills often preferred to buy those that had already been cut to a point. If they bought the uncut quills it was a simple matter to slice the point with a small knife to suit their own manner of writing—and it is from this quill-cutting that we get the term 'penknife'.

It may surprise you to learn that quill pens are still being made and sold in England and the United States; more than eleven hundred such pens are supplied every year by the Supreme Court of the United States to the attorneys who practise before the Court. In England some legal firms use them for writing important documents, and there is a workshop in Buckinghamshire which makes over 3,000 quills a year.

In 1780 a Birmingham manufacturer, Samuel Harrison, made metal pen-points with wooden holders for Dr Joseph Priestley, the scientist. Metal pen-points were not altogether new, since one made of bronze was found in the ruins of Pompeii, the Italian city destroyed when the volcano Vesuvius erupted in A.D. 79. They were not, however, in common use; and although a patent was issued in 1830 to a Londoner by the name of Wise for his invention of steel nibs, they were still too costly to become popular.

In 1809 another Englishman, Joseph Bramah, inventor of the hydraulic press and the safety lock, developed the

idea of cutting a single goose quill into five or six short lengths and fitting each piece into a holder, thus making five or six pens from one quill.

It was not long before steel nibs captured the public fancy, and around 1830 James Perry, Mitchell Gillott, and Sir Joseph Mason, of Birmingham, began to produce steel nibs by machinery, which meant that they could be sold almost as cheaply as the quills. Birmingham is still the principal steel-pen centre.

Today most of us carry fountain-pens or ball-point pens in our pockets. Fountain-pens—that is, pens having their own ink supply—were made in England as far back as 1835, but were considered a fad and were not successful, nor did they work satisfactorily. The first practical fountain-pen was patented in 1884 in the United States by Lewis Edson Waterman, and the pen company he established is still prospering at Seymour, Connecticut.

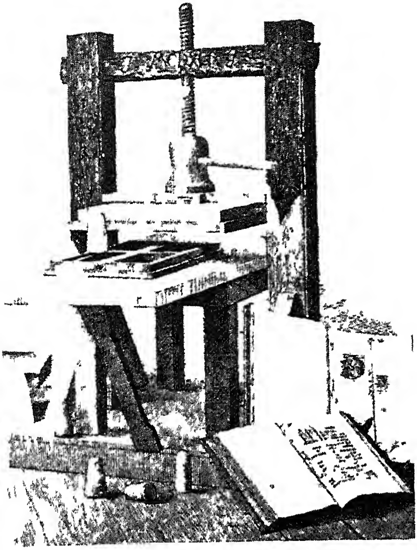
Waterman invented his fountain-pen for his own use, to avoid any recurrence of an accident that lost him an insurance client and a large sum of money. As an insurance agent in New York City, Waterman was required to have all insurance applications signed in ink; so for a time he carried with him a collapsible 'dip' pen and a bottle of ink. One day, however, he almost upset the ink, which would have ruined not only his insurance papers but his clothes as well, and he decided to buy one of the new-fangled 'fountain' pens on the market.

Soon afterwards Waterman was negotiating with an important prospective client, who asked for a large amount of insurance. With a big smile Waterman placed the application form on his client's desk and handed him the fountain-pen with which to sign it. The man touched the point of the pen to the paper and an instant later a river of ink flooded the application and the man's shiny desk!

He jumped out of his chair, glared at the pen, then at Waterman. 'Take this leaking monstrosity out of here!' he shouted, pushing the pen at Waterman.

LEFT. Christopher Latham Sholes, inventor of the typewriter. RIGHT. His daughter operating the first working model, 1872.

The first commercial typewriter, Remington No. 1.



LEFT Gutenberg's printing press Notice the carved date MCDXLI (1441) and the initials J G on the cross-beam. BELOW. Gutenberg lifts a page printed from his movable type.

Waterman returned to his office, had another application drawn up, and again called on the man—only to learn that he had taken out a policy with another company.

Looking at the leaky fountain-pen, Waterman set out to make one of his own that he could depend upon at all times. The big problem was to regulate the flow of ink, for this was the obstacle that the makers of the fountain-pens on the market had been unable to overcome.

Filling the pens was no problem; but no pen had yet been made that would deliver the ink to the point, starting and stopping as required by the writer. After studying various models of fountain-pens then on sale Waterman began working on a 'feed' to control the flow of ink. He spent night after night testing and discarding various new ideas. After many discouraging experiments he decided to make two saw-cuts, one alongside each wall of a shallow, square channel. The idea was that these cuts, or slits, would allow the ink to flow and the space above the slits would admit air, thus letting air and ink travel in opposite directions at the same time. The pressure of one would offset that of the other. He tried it out—and it worked! Later he added a third cut in the middle of the main channel and applied for a patent for the Waterman Fountain Pen. The patent was issued on 12 February 1884.

Waterman's pen worked so well that his friends and business acquaintances persuaded him to give up his life-insurance business and to make and sell his fountain-pens. His first 'factory' was a kitchen table in the rear of a small cigar store in New York City. The basic principle of ink control invented by Waterman remains unchanged today and is still used on various kinds of fountain-pens other than the ball-points.

Even in its heyday the fountain-pen never enjoyed as much popularity as the ball-point pen, which has revolutionized people's writing habits in every country since

the end of the Second World War. The story of its invention goes back to 1938. In the Argentine a poor Hungarian, who had fled from his country when its government got too friendly with Hitler, was looking for someone to finance his invention—a pen with a tiny steel ball instead of a nib, fed with ink from a narrow, vein-like tube. The Hungarian, Lászlo Biro, had already tried a good many jobs in his lifetime: he had been a hypnotist, a printer's proof-reader, and a painter, among other things.

For nearly five years Biro searched in vain for a backer. Then, in 1943, an English industrialist, Henry Martin, who happened to visit the Argentine, met the Hungarian and recognized at once the possibilities of the new writing implement. He teamed up with another British business man, Frederick Miles, who provided the R.A.F. with non-leaking pens during the war. Already in 1946 the first ball-point pens were on sale in America. But a further improvement was needed before the invention could start its triumphal march. An Austrian chemist, Franz Seech, working in his wife's kitchen in California, invented a rapid-drying, non-smudging ink, based on glycol as a solvent.

The first Biro pens cost anything up to thirty-five shillings; today ball-point pens can be had for as little as sixpence. This low price is mainly due to the fantastic demand for them. In Britain the number of these pens sold in 1953 was 17 million; ten years later it was 150 million!

Another writing instrument found in every home, office, and schoolroom is the lead pencil, from the Latin *penicillus*, meaning 'brush' or 'little tail'. (Some kinds of artists' brushes are still known as pencils.) Some two thousand years ago the Egyptians used pieces of lead for the marking of hieroglyphs on papyrus, which shows that the principle of the pencil is quite ancient—but you may be surprised to learn that the 'lead' pencil as we know it does not have any lead in it! Its marks are made

by a form of carbon called graphite (from the Greek *graphein*, meaning 'write').

Graphite first appeared about 1400 in England, and for a long time was simply sold in sticks, or pieces, without any covering. Pedlars went from door to door crying their wares:

> Buy marking stones, marking stones buy,
> Much profit in their use doth lie;
> I've marking stones of colours red,
> Passing good—or else black lead.

The coloured sticks were wax crayons; the black lead was graphite.

By the seventeenth century the salesmen were winding string around the graphite pieces, not only to keep the users' hands clean but also to protect the carbon. The cord was simply unwound as the graphite was used. Later improvements included a metal holder, and finally, about 1686, someone discovered that narrow lengths of graphite could be fastened between two strips of wood—a method that marked the beginning of the modern wooden pencil.

Most of the graphite used and sold in England came from the Borrowdale mines in Cumberland, and it was so pure that it was used in its natural state. However, just as Egypt tried to conserve the papyrus by prohibiting its exportation, shipments of graphite from Borrowdale were restricted, for the supply was rapidly dwindling. The mines eventually closed down altogether.

Merchants sought frantically for a substitute for the Borrowdale graphite. Although other sources were found, none produced graphite as pure as that from Borrowdale and new processes had to be devised to refine it. Refining reduced the graphite to a powder; so it had to be mixed with other materials, such as gum or resin. These were unsatisfactory, and it was not until 1795 that a Frenchman named Jacques Conté, of Paris, discovered a method of mixing graphite with wet clay, cutting it into thin

strips, and baking it in an oven. By mixing different proportions of clay and graphite he could produce writing instruments of varying degrees of hardness.

Today the world gets graphite from various countries, including Ceylon, New Zealand, Mexico, Germany, Norway, and the United States. A mine in Ticonderoga, New York, produces graphite which is almost pure carbon, undoubtedly as good as that which once came from Borrowdale. Although graphite is now used for many purposes, much of it continues to go into the making of lead pencils.

The Venus Pencil Company in London give the following as some of the materials used in the making of lead pencils: cedar, from Kenya and California; gold, from South Africa; rubber, from Malaysia; clay, from England and Germany; graphite, from Ceylon, Korea, and Mexico; gum, from Persia; colours and dyes, from Britain; waxes, from Japan, Africa, Brazil, and Britain; carbon black, from the United States.

The reed pen brought about many changes in the shapes of the letters of the alphabet. When the ancients had to carve symbols or letters into stone or clay, it was easier to make straight lines and sharp angles than to make rounded lines or circles; but when they began to write with pen or brush and ink, they wrote much faster and started to round off many of the letters that had once been angular. By the time the steel pens and lead pencils came into use the letters of our alphabet were practically the same as we know them today.

Pens, pencils, and paper made possible more books, more letters, more education, more communication between people than ever before; but although they made writing much easier and much faster than carving, men still sought ways to put down words with more speed. Centuries ago teachers and philosophers uttered words of great wisdom in their lectures; but the words were not written down unless the speakers themselves chose to

take time to do the writing, and others who were able to write could not do so fast enough to make a faithful record while the wise men spoke. To solve this problem, a one-time Roman slave invented what we now call 'shorthand'.

The slave, Marcus Tullius Tiro, was given his freedom by Cicero, the Roman orator and statesman, and became Cicero's friend and secretary. In 63 B.C. Tiro created a method of making mysterious notes which he used to write down his employer's speeches and which he alone could translate into understandable language. A short mark or two might represent one or two whole words. After Cicero made a speech, Tiro would transcribe the notes and Cicero would make any desired changes in the wording before it was copied by the scribes.

Tiro taught his system to others, who became shorthand reporters, and his shorthand symbols later became known as *notae Tironianae*. Some authorities believe, however, that a shorthand system had been developed earlier by the Greeks and that Tiro's idea came from Greece. At any rate it would seem that our modern students of Latin can thank (or blame) Tiro for preserving the speeches of Cicero that they study in our classrooms.

With various modifications, shorthand spread from one country to another. It is believed that the Apostle Paul dictated to a shorthand reporter his Epistle to the Colossians, and that other early Christians found shorthand useful in spreading the Gospel. Many of them, of course, could not read or write at all; so if it became necessary for one of these to sign his name to a document he simply made a cross (+), indicating that he was a Christian. Twentieth-century illiterates still use × as a signature.

Modern shorthand can be traced to 1588, when an Englishman, Dr Timothy Bright, created a shorthand system which he described in a published book dedicated

to Queen Elizabeth and entitled *Characterie; the Art of Short, Swift, and Secret Writing, by Character.* Charles Dickens was once a shorthand reporter, recording speeches in the House of Commons in London.

Other men developed various methods of fast writing. Three that have come down to our own time were invented by Isaac Pitman of Bath, John Robert Gregg of Rockcorry, Ireland, and Reginald J. G. Dutton. Pitman called his system 'Stenographic Sound Hand' and published text-books on it in 1837 and 1840. Gregg, who made a careful study of many shorthand methods, devised the one that still bears his name and described it in a manual called *Light Line Phonography, the Phonetic Hand Writing* (1888). Dutton's shorthand, invented in 1916, is a geometric and phonetic system. On the European continent Franz Xaver Gabelsberger invented, early in the last century, an efficient shorthand system which is still widely used, in a modified form, in all German-speaking countries.

There are now machines such as the 'Stenotype', with which trained operators can keep up with the fastest speakers merely by depressing a few keys that print letters on a long narrow roll of paper.

Shorthand today goes hand in hand with typewriting, and the machine we call the typewriter would have amazed the Egyptians, Greeks, and Romans who once considered the goose quill the ultimate for writing purposes.

The first record of any effort to make a writing machine is a British patent granted by Queen Anne to an engineer named Henry Mill on 7 January 1714. In part this patent reads:

> Whereas our trusty and well-beloved subject, Henry Mill, hath by his humble petiçon represented unto us that he has, by a great study, paines, and expence, lately invented and brought to perfection 'An artificial machine or method for the impressing or transcribing of letters, singly or progressively one after another, as in writing, whereby all writings whatso-ever may be engrossed in paper or parchment so neat and exact

as not to be distinguished from print; that the said machine or method may be of great use in settlements and public recors [*sic*], the impression being deeper and more lasting than any other writing and not to be erased or counterfeited without manifest discovery', and having therefore humbly prayed us to grant him our Royall Letters Patent for the sole use of his said invention for the term of fourteen years . . .

If Henry Mill ever made a model of his machine it was never found, and any drawing that may have been submitted with the patent was either lost, stolen, or destroyed, so that no one knows what Mill's contraption looked like. According to one authority, it was a machine with raised letters made especially for use by the blind.

The first man in the United States to obtain a patent on a typewriter was William Austin Burt of Detroit, Michigan, famous as the inventor of the solar compass. Burt's machine was patented in 1829 but was never manufactured. A replica of Burt's machine is on display in the Smithsonian Institution in Washington, along with a notice reading: 'William Austin Burt made the first typewriter known to have been capable of practical work and the earliest of all typewriting machines of which we now have any details of construction.'

There were many other attempts to make writing machines, but none was practical enough to warrant production for general use. One invention, patented in 1857 by Dr Samuel W. Francis of New York City, had ivory keys like those of a piano which the operator could 'play' to type a letter!

In 1866, following the end of the Civil War, three middle-aged men worked on inventions in a small machine shop near Milwaukee, Wisconsin. In that shop the modern typewriter was born, almost by accident.

The men were Christopher L. Sholes, Carlos Glidden, and Samuel W. Soulé. Sholes and Soulé, who were printers, were trying to build a device that would put page numbers in proper sequence on blank books and

ledgers. Glidden was making a mechanical 'spader' that would replace the plough.

Occasionally they discussed each other's progress, and one day as Glidden looked over Sholes's numbering machine he said, 'You know, Chris, it would really be something if you could make this contraption so's it would write letters and words, as well as numbers.'

Sholes laughed. 'It sure would', he answered. He did not consider the suggestion seriously at the time, though apparently he didn't forget it completely. He was reminded of it about a year later when he read an article in a scientific journal about an English invention called the 'Pterotype', created by John Pratt, which would 'write letters and words, as well as numbers'.

Sholes decided that he could make a better, more compact, more efficient machine than Pratt's. He discussed his ideas with Glidden and Soulé, who agreed to help him, along with a mechanic named Matthias Schwalbach, who had worked with Sholes on the numbering machine.

A working model of the writing machine was completed late in 1867 and, although it wrote only capital letters and was rather crude, the men found that it was both accurate and fast. In 1868 it was patented under the name given to it by Sholes—the 'Type Writer'. The arrangement of the keyboard was designed by Sholes and basically has never been changed.

Sholes, who was also very active in politics and who had held political jobs, is reported to have originated the sentence 'Now is the time for all good men to come to the aid of the party' as a typewriter exercise.

To manufacture the machine the men needed money, so they wrote letters to various friends inviting them to invest in the business. One of these, a printer named James Densmore, of Meadville, Pennsylvania, not only became a partner in the business but also continually urged Sholes to build better models before putting the

device into production. In 1873, after some twenty-five improved models had been built and tested, the men entered into a contract with E. Remington and Sons, Ilion, New York, to manufacture the typewriter.

Sholes reportedly sold his interests to Densmore for twelve thousand dollars, which is all that the inventor of the typewriter received for the machine that could have made him a very rich man. He died twelve years later. 'I've tried hard not to become a millionaire', were his last words. 'I guess I've made a success of it.'

When business firms first began to use typewritten instead of handwritten letters, they had some unusual reactions from some customers, who evidently looked upon the printed words as an insult. They returned typed letters to the senders pointing out that they could read handwriting so it was not necessary to 'print' letters for them. Mark Twain, the great humorist, was the first author to try the machine out, but soon banished it to a corner of his study from where it 'watched him reproachfully'.

People who could read and write were very few in the days when books and papers were hand-lettered on papyrus or parchment. Once a book was written the only way copies could be made was by having them transcribed by hand. The making of reproductions became an important activity of the European monasteries, with the monks doing the lettering in a part of the monastery known as the 'scriptorium'. The books were valuable and were usually kept on chains or under lock and key in the monastery libraries.

Centuries after the art of writing had been mastered by many peoples copying was still a problem. Once again the ancient Chinese were among the first to invent a process that was to sweep across the world—a process that made possible the book you are now reading. We call it 'printing'.

6

BIRTH OF THE PRINTING PRESS

In 1900 a Chinese holy man began to 'restore' one of the ancient Caves of the Thousand Buddhas—caves that had been dug into a sheer cliff some fifteen hundred years earlier and used as homes by a group of religious families in the desert country around Tunhwang (now in the Chinese province of Kansu). In the course of his restoration the priest dislodged a stone which revealed part of a brick wall. With great care he removed a few bricks, peered through the opening, and was startled to see a vaultlike room practically filled with ancient rolled manuscripts!

It is believed that the cave dwellers were about to be attacked by their enemies and that in A.D. 1035 or thereabouts they hid the manuscripts in the secret chamber to prevent their theft and destruction.

In 1907 Sir Aurel Stein, a famous archaeologist, bought some three thousand of the manuscripts for study and deposited them in the British Museum in London. They had been written in Chinese, Turkish, Hebrew, Persian, and other languages and, while they were all of great historical value, one among them stood out as a prize discovery. It was a book on a paper roll about sixteen feet long, not handwritten but printed in Chinese from wood blocks, and it carried this statement: 'Printed on 11 May 868 by Wang Chieh, for free general distribution,

in order in deep reverence to perpetuate the memory of his parents.'

This roll, a Buddhist scripture known as the Diamond Sutra, is the oldest printed book yet known and, since it clearly states that it was printed by Wang Chieh, it supports the belief that the art of printing originated with the Chinese.

The Chinese did their printing from wood blocks, cutting away the parts of the wood not intended to be inked and leaving letters or pictures in reverse and in relief. Their ink, a mixture of lampblack and resin or gum, was spread over the surface of the block, and paper was pressed upon it. When it was lifted off, the paper carried an impression of whatever was in the relief design on the wood.

The Chinese eventually discovered that instead of carving a wood block for a whole page they could carve blocks for individual characters, combine them to form sentences, and use them over and over again. In other words, the Chinese were the first to use movable type. However, because of the thousands of characters in the Chinese language, it proved to be easier to use the page-size blocks, and it was not until hundreds of years later that the use of movable type found its way into Europe and made famous the name of Johann Gutenberg.

No one knows for sure just when movable type was first used in Europe, although it was probably around 1440. Also, contrary to popular opinion, it cannot be said conclusively that Johann Gutenberg was the European inventor of movable type.

Gutenberg's real name was Johann Gensfleisch. He was born a few years before 1400 in Mainz, Germany, and later took the name of the district of the town where his family lived, the Gutenberg.

When Johann was about thirty years old he went to live in Strasbourg, and here he evidently began his career as a printer. Whatever new developments Gutenberg

created in the printing art were shrouded in secrecy, but in 1439 he became involved in a lawsuit which raised the curtain slightly on some interesting activities of his.

Complete records of the lawsuit are not available, but from those which do exist it appears that Gutenberg was approached in 1438 by one Andreas Dritzehn, who persuaded Gutenberg to teach him certain arts that would make him rich. The first such art was that of 'polishing stones', from which Andreas 'derived great profit'.

Next, Gutenberg and Hans Riffen, Mayor of Lichtenau, formed a company which Andreas Dritzehn and a man named Andreas Heilman wanted to join. Gutenberg agreed, provided they would pay him a specified sum of money in return for one-third of the profits. Apparently Gutenberg kept some of his secrets to himself, so Dritzehn and Heilman offered him more money if he would reveal to them everything he knew about his secret processes. The four partners then decided that they would work together for five years and that if one died his entire share and holdings would belong to the survivors, who would pay one hundred florins to the heirs of the dead partner.

Andreas Dritzehn soon died; and when news of his death reached Gutenberg he sent a trusted assistant to Dritzehn's home, where there was a printing press belonging to the partners. The assistant was instructed to disconnect parts of the press, bring some of them back to Gutenberg, and rearrange others 'in such a manner that no one might be able to understand what they were'. Unfortunately for Gutenberg, his assistant failed to bring back all of the important parts; and when a later search was made for them, many 'were not to be found'.

Gutenberg offered to pay Dritzehn's family a hundred florins, as agreed, but the family demanded an accounting of the investment that Andreas had made in the business, and said they knew he had spent some money for lead.

Gutenberg refused the demand and they brought him to court.

The testimony of witnesses threw some light on the group's mysterious operations. The partners had worked late at night. They had borrowed money because their project was one that could be profitable. What was the project? Witnesses who had asked this question reported that the partners said only that they were 'mirror makers' (*Spiegelmacher*).

The witnesses included a turner (lathe-worker), a lumber merchant, and a goldsmith. It was the goldsmith who gave a direct clue to the mysterious work the men had been doing. He said he had been paid by Gutenberg for three years and prepared for him 'the things which had to do with *printing*'.

Strangely enough this first mention of the nature of the project did not arouse any unusual interest, and both court and public held the impression that the partners had been engaged in some secret art having to do with the polishing of stones and the making of mirrors. The judge ruled that Gutenberg had lived up to the terms of the original agreement and that the remaining partners were the sole proprietors of the process, whatever it was.

One source offers a logical explanation of the 'mirror-making' references, suggesting that Gutenberg and his associates were planning to print copies of a book entitled *Speculum Humanae Salvationis* ('Mirror of Human Salvation'), so that when they said they were 'mirror makers' they were not being completely untruthful. They simply wanted to keep secret what they had learned about the new art of printing.

The Strasbourg project was not successful and Gutenberg returned to the town of Mainz, where he resumed his experiments. He invented new tools; made a hand printing press built on the same principle as a wine press; and made movable types of wood, lead, and iron, each letter having to be engraved. His money soon ran out and

he had about decided to go into some other work when he was approached in 1450 by a rich goldsmith named John Fust (or Faust) who wanted to go into partnership with him.

Fust advanced Gutenberg money for tools, paper, ink, and for other expenses—proposing that the partners undertake the printing of a Bible in large type, with capital letters and initials to be illuminated, or painted in colour. To do this art work a man named Peter Schoeffer was brought into the shop by Fust.

Schoeffer was an ingenious and shrewd student. While working in Gutenberg's shop he invented a mould in which he could make separate metal casts of all the letters in the alphabet. This was a great step forward, since it eliminated the necessity for engraving the separate letters. Schoeffer kept his secret from Gutenberg, but revealed it to Fust. As a goldsmith, Fust knew the idea was practical and he carried it out, casting sets of letters which he delivered to Schoeffer. With this type Schoeffer evidently printed a book, the *Donatus*, of which four parchment pages were discovered in France in 1803. One page carries an inscription showing that the book, the type, and the initial letters were made by Peter Schoeffer alone, according to the 'new art of the printer, without the help of the pen'.

Gutenberg, meantime, continued to work on the printing of the Bible, using the movable type he had invented. Schoeffer and Fust schemed to drive him out of the business and take over the production of the Bible themselves. Fust demanded that his partnership with Gutenberg be dissolved and that his investment be returned. Gutenberg was penniless and could not pay, so Fust forced him by a lawsuit to give up his printing shop and all equipment—including the Bible, which was almost complete.

Schoeffer married Fust's daughter and with his new father-in-law finished the Bible in 1456. It consisted of 1,282 pages, bound in two, three, or four volumes. It was printed in two columns of forty-two lines each, some

copies on vellum, or parchment, others on paper. Probably they produced 150 copies in all and sold most of them at high prices.

Fust brought copies of the Bible to Paris and offered them for sale as manuscripts at sixty crowns each, while others were charging five hundred crowns, and his competitors accused him of being a magician in league with the devil. They complained to the authorities, who searched Fust's rooms and found several copies of the Bible. He was brought to court and threatened with burning at the stake, and to save himself he revealed his secret to the French Parliament. The lawmakers, marvelling at the new invention, ordered Fust's release. Fust and Schoeffer thus claimed the method of printing as their invention, and Gutenberg did not dispute the claim.

The Bible completed by Schoeffer and Fust is known today as 'the Gutenberg Bible'. A few copies are still in existence, including one in the British Museum, London. Gutenberg himself, after having been tricked out of his own invention, had no means of setting up another workshop. A kindly cleric took him in as his guest, and he died in 1468.

This story of the invention of printing by movable type is not without its shadows and contradictions, for some historians have unearthed information which implied that Fust, or even Gutenberg himself, may have stolen the movable-type idea.

In 1572 a scholar named Adrian Junius wrote a Latin work, entitled *Batavia*, in which he claimed that the art of printing was discovered in Holland. Here is a translation of Junius's account:

> More than one hundred and thirty-two years ago there lived at Haarlem, close to the royal palace, one John Laurent, surnamed Coster. . . .
>
> One day, about 1420, as he was walking after dinner in a wood near the town, he set to work and cut the bark of beech trees into the shape of letters, with which he traced, on paper,

by pressing one after the other upon it, a model composed of many lines for the instruction of his children.

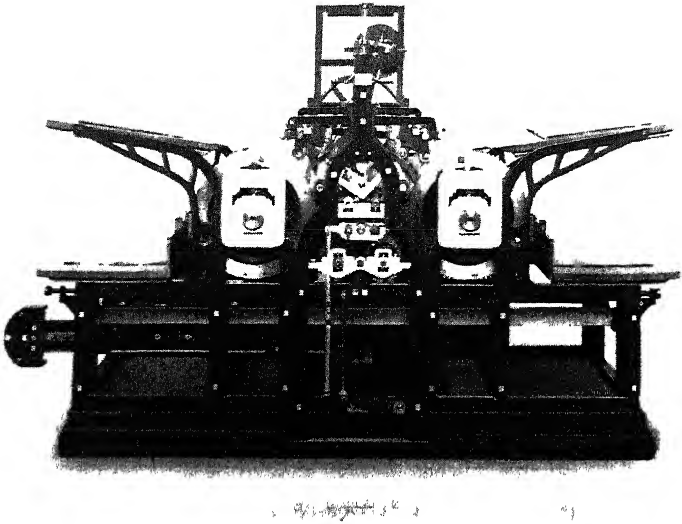
Encouraged by this success, his genius took a higher flight, and then, in concert with his son-in-law, Thomas Pierre, he invented a species of ink more glutinous and tenacious than that employed in writing, and he thus printed figures [images] to which he added his wooden letters. I have myself seen many copies of this first attempt at printing. The text is on one side only of the paper. The book printed was written in the vulgar tongue, by an anonymous author, having as its title *Speculum nostrae Salutis*. Later, Laurent Coster changed his wooden types for leaden ones, then he made them of pewter.

Laurent's new invention, encouraged by studious men, attracted from all parts an immense concourse of purchasers. The love of the art increased, the labours of his workshop increased also, and Laurent was obliged to add hired workmen to the members of his family to assist in the operations. Among these workmen there was a certain John, whom I suspect of being none other than Faust, who was treacherous and fatal to his master.

Initiated, under the seal of an oath, into all the secrets of printing, and having become very expert in casting type, in setting it up, and in the other processes of his trade, this John took advantage of a Christmas evening, while everyone was in church, to rifle his master's workshop and to carry off his printing implements.

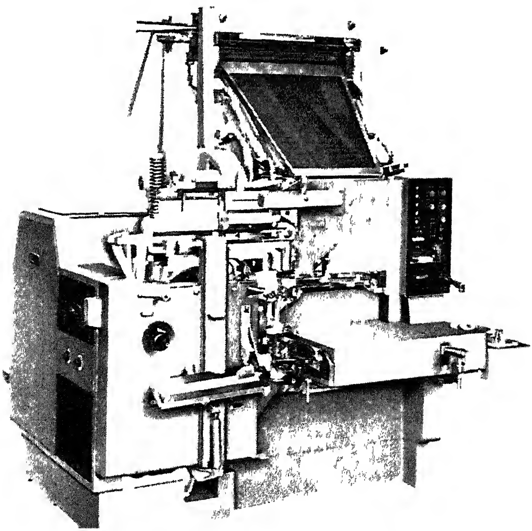
He fled with his booty to Amsterdam, thence to Cologne, and afterwards to Mayence [Mainz], where he established himself; and calculating upon safety here, set up a printing office. In that very same year, 1422, he printed with the type which Laurent had employed at Haarlem, a grammar then in use, called *Alexandri Galli Doctrinale*, and a *Treatise of Peter the Spaniard*.

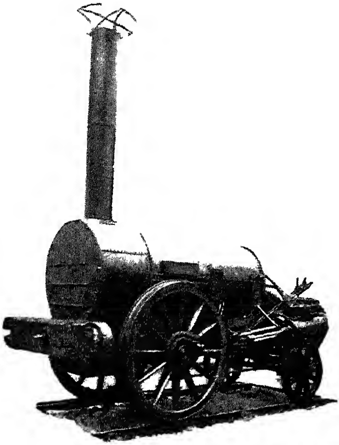
Interested scholars began to explore the Coster story as told by Junius. In Cologne they discovered an anonymous chronicle which contained some information allegedly obtained from one Ulric Zell, who had worked for Gutenberg. 'Although the typographic art was invented at Mainz', this account said, 'nevertheless the first rough sketch of this art was invented in Holland, and it is in imitation of the *Donatus*, which long before that time was printed there; it is in imitation of this, and on

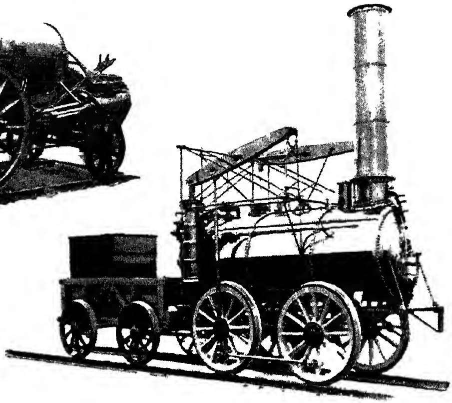


Konig's steam press, first used to print *The Times* for 29 November 1814.

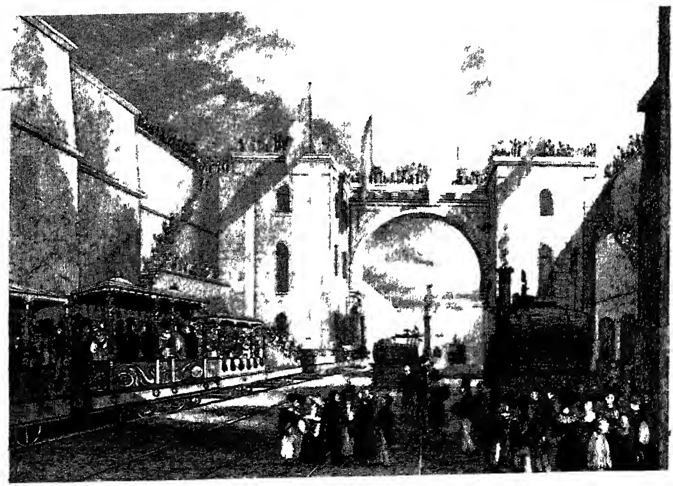
The 'Monarch', a keyboardless, high-speed, tape-operated composing machine which can set fourteen column-width lines a minute.







ABOVE LEFT. Stephenson's famous 'Rocket'. RIGHT. The 'Stourbridge Lion', the first locomotive to run on an American railway, 8 August 1829. BELOW. The opening of the Liverpool and Manchester Railway, 15 September 1830.



account of it, that the said art began under the auspices of Gutenberg.'

Obviously, if it were true that Gutenberg simply imitated the *Donatus* which was printed in Holland before he began printing in Mainz, and if the original *Donatus* had been printed with movable type, Gutenberg cannot be called the inventor of this method of printing in Europe. But the Coster story has not been accepted as definitely true by the historians.

Adrian Junius suspected that the mysterious 'John' who ran off with Coster's equipment was John Fust, or Faust. Some Dutch writers, however, alleged that 'John' was actually John (Johann) Gutenberg; and still others believed that it was one John Gensfleisch, a relative of Gutenberg.

War and intrigue were responsible for the spread of printing to other European nations. In 1462 Louis XI of France, having heard about Gutenberg and his printing press, summoned a clever engraver named Nicolas Jenson, employed in the French Mint at Tours, and gave him a confidential mission 'to obtain secret information of the cutting of the points and type, by means of which the rarest manuscripts could be multiplied, and to carry off surreptitiously the invention and introduce it into France'.

Jenson double-crossed his king. After he succeeded in learning the art of printing at Mainz, the spy fled to Venice and set up shop as a printer.

Louis XI then selected a more trustworthy agent and sent him to Mainz on the same mission. This time the king had better luck; for his man returned with the printing secrets, and in 1469 three German printers began to turn out books in Paris.

In 1462 the town of Mainz was attacked, captured, and looted by its enemies. The printing shop operated by Fust and Schoeffer was closed for two years; and the printers they had trained headed for safety in other cities,

notably Cologne, Hamburg, and Strasbourg. Two of the men crossed the Alps and found sanctuary with some German monks in a monastery in Rome, where they set up apparatus and printed several fine editions of Latin books. By 1476 there were more than twenty printers in Rome, operating about a hundred presses.

In Venice the traitor-spy, Jenson, suddenly found competition when John de Spire arrived from Mainz and opened a rival print-shop. Numerous other printers drifted into Venice, from where they could market books on hundreds of ships sailing to other parts of the world.

One of the most celebrated Venetian printers was Teobaldo Mannucci, better known as Aldus Manutius, who became famous for his published editions of the works of Aristotle, Thucydides, Sophocles, Plato, Dante, and others. Manutius did not like the idea of having his native Venice identified only with a type introduced by a Frenchman; so he used a type face cut by a man named Griffo, which we now call *italic*.

There is a legend which identifies Manutius as the originator of the term 'printer's devil', usually applied to a new apprentice in a printing plant. According to the legend, Manutius brought a Negro boy to Venice and put him to work in his establishment. Their belief in witchcraft and superstition led the Venetians to believe that the Negro was some kind of evil messenger.

Manutius, hearing this frequent rumour, sought to dispel their fears once and for all by issuing a public notice somewhat as follows: 'I, Aldus Manutius, Printer to the Doge, have brought into my service a boy of dark skin who is claimed by some to be the printer's devil. On the morrow this boy will be placed on public view, and any who believe that he is not real flesh and blood may come and pinch his skin.'

A more likely origin of the term is that young apprentices in printing shops were constantly daubed with inks

of various colours and were jokingly called 'devils' and sometimes 'flies' by the printers they assisted.

Virtually all books were printed in Latin until about 1476, when printing was introduced in England by William Caxton of Kent, who produced his volumes in English. Caxton was a wealthy merchant who had acted as an emissary of the Duchess Margaret, sister of King Edward IV, in negotiating a commercial treaty with the Duke of Burgundy. While abroad he learned about printing and set up his own press in Bruges, and later he brought his knowledge to England. In some fifteen years Caxton printed about a hundred books; he died in 1491.

In the western hemisphere printing probably began about 1539, when an Italian named Giovanni Paoli landed in Mexico with his equipment and started a printing business. It was almost a hundred years later that the first printing press began to operate in the United States.

The art of printing helped to bring the 'Dark Age' of ignorance and superstition in Europe to an end. New ideas spread far and wide by means of the printed word. The common people began to learn to read; books, news-sheets, and later newspapers told them about scientific discoveries, world events, and philosophers' concepts. Martin Luther's treatise, *On the Liberty of a Christian Man*, printed and distributed in many thousands of copies, prepared the minds of men for the Reformation.

The technique of printing, however, changed little from the fifteenth to the early nineteenth century—until a mechanic from Saxony, Friedrich König, invented the steam-operated mechanical printing press, which increased the rate at which newspapers could be printed from about 250 to 1,200 sheets an hour. The first paper printed in this manner was the issue of *The Times*, London, of 29 November 1814. It had to be printed in secret because the hand printers, fearing for their livelihood, threatened to smash up the new machines.

An American, William Bullock, in 1865 invented the first press to print a newspaper from a continuous roll of paper such as those in use today. Later came the rotary press, folding machines, and other devices designed to handle news while it *was* news and to get it to the public speedily and at low cost.

7

THE NEWSGIVERS

THE REPORTING of news, or current events, actually began before Christ was born, and it is likely that the ancestor of the modern newspaper first appeared in Peking, where the Chinese produced handwritten sheets describing important events.

In the days of the Roman Empire written accounts of the actions of the imperial armies were sent to the heads of all commands so they would know what the total force was doing. These news reports were called *Acta Diurna* ('Daily Actions'), and copies of them were sent to the provinces to be posted as public news bulletins.

Centuries later, in 1566, the government in Venice also issued written sheets of news called *Notizie Scritte* ('Written Notices') which were posted in the streets, but before anyone could read them he had to pay an Italian coin called a *gazetta.* The sheets were in such demand that the government began to print them monthly and to call them *gazettes*, after the coin. The gazettes were the forerunners of the modern newspaper.

The spreading of news became vitally important when the Spanish Armada bore down upon the English coast in 1588; for false rumours were started by Spanish spies and sympathizers, and the government wanted to tell its people the truth. Queen Elizabeth authorized the printing of a newspaper called the *English Mercurie*, which denied many floating rumours and reported the true military situation. Although some of these papers are

preserved in the British Museum, it is believed that they are forgeries and not the originals.

When men learned the art of printing, some of them published single sheets printed on one side only and describing one or more newsworthy events. The first regularly appearing news-sheet was the *Avisa Relation oder Zeitung*, published in Strasbourg in 1609.

The true birthday of the British press was 23 May 1622, on which day appeared the first issue of the *Weekely Newes* 'from Italy, Germanie . . .', published by Thomas Archer and Nicholas Bourne—the forefathers of regular journalism in England. They had no easy task; the authorities of the time had grown extremely apprehensive of the possible dangers of letting the people know what the Government preferred to remain unknown. Restrictions on the free publication of news—'censorship', as we call this practice today—were so severe that these pioneers of journalism preferred to print only news items which they could prove to have copied from foreign sources. Until the notorious *Star Chamber*, whose main function was the suppression of free speech and civil liberty, was abolished in 1641, the newspapermen led a rather perilous life.

In the Civil War both sides recognized the propaganda value of newspapers; the Parliamentarians, for instance, had their publication called *Britannicus* and the Royalists their *Aulicus*. These papers had only a short life; but the year 1665, when the court fled to Oxford to escape the plague, saw the birth of a paper which is still in existence as the official organ of the British Government. One Henry Muddiman (of whom Pepys the diarist drew a rather unflattering character sketch) started the *Oxford Gazette*, which was later transferred to the capital as the *London Gazette*.

It was only in 1692 that the Licensing Act, which restricted the publication of newspapers, was allowed to lapse, and a year later the censorship came to an end. Thus the eighteenth century became an epoch in which

the press developed to a high standard, and in which many famous names were associated with journalism: Swift and Defoe, Addison and Steele, Fielding and Goldsmith—and of course Dr Johnson.

Jonathan Swift (1667–1745) was the editor of a Tory magazine, the *Examiner*. Daniel Defoe (*c.* 1661–1731) started his *Review* in 1704; it was an ambitious journalistic enterprise, but most of the contributions were by his own pen. Joseph Addison (1672–1719), the essayist, poet, and statesman, was particularly interested in a twice-weekly magazine called the *Tatler*, which appeared first in 1707 without mentioning the real name of its editor; after a number of weeks, Addison discovered that the man behind it was no other than his friend, Sir Richard Steele (1672–1729), and thereafter became one of the principal contributors. A few years later the two men founded the *Spectator*, which was, however, short lived; but both journals were revived much later and still play an important part in British journalism.

Henry Fielding (1707–54) achieved such fame as a novelist that his success as a journalist—with the Whig periodicals the *True Patriot* and the *Champion*—became almost forgotten. Samuel Johnson (1709–84) was a regular contributor to the *Gentleman's Magazine* and also published his own periodicals, the *Idler* and the *Rambler*.

The first English daily newspaper, the *Daily Courant*, was started in 1702, and the first evening paper, the *Evening Post*, four years later. Thus England had a varied and flourishing press in the eighteenth century. Yet political comment was hampered by the curious fact that reporting of parliamentary debates was not permitted until 1772. This restriction, as well as the whole problem of the freedom of the press, excited public opinion very much in 1762 as a result of the case of John Wilkes (1725–1797), a member of the House of Commons and a brilliant journalist, who edited the journal *North Briton*. In it he attacked the king's speech at the opening of

Parliament. He was imprisoned for libel and expelled from Westminster. When, in 1771, Wilkes became Lord Mayor of London he did all he could to protect reporters, and finally succeeded in obtaining permission for the press to print parliamentary reports.

In 1785 a former coal-merchant, John Walter, began the publication of the *Daily Universal Register*, which was three years later given a new name, *The Times*; another journal which is still in existence was first published in 1791, the Sunday paper *The Observer*. Other late eighteenth-century papers such as the *Morning Post* and the *Morning Chronicle* have since died.

The British press had won its freedom, but the rulers of the country regarded it still as an opponent and troublesome critic. If the newspapers could not be muzzled they could be taxed. In 1712 a stamp tax of 1*d.* per half-sheet was introduced; and successive governments increased this rate little by little until, in 1815, the tax was as much as 4*d.* per copy—with the result that *The Times* had to put up its price to 7*d.* However, the fight against the stamp tax, too, was won in the end by the press, and it was finally abolished in 1855.

The development of the modern mass-circulation papers was made possible only by the introduction, after 1875, of newsprint—paper made from cheap wood-pulp. Thus the twentieth century became the period of the press lords with their vast empires of cheap reading matter, often accompanied by the lowering of intellectual standards and taste, the incessant chase after sensations, the prying into private affairs, the overriding importance of advertising. While the circulation figures of such papers rose ever higher, a number of others were squeezed out of existence. The most important of them was, in 1960, the Liberal *News Chronicle*; it had begun, as the *Daily News*, with Charles Dickens as its first editor, in 1846, and was later combined with the *Daily Chronicle*. The other great Liberal paper, the *Manchester Guardian*, took the opportunity

to 'move south' by arranging for simultaneous printing in Manchester and London by the latest methods. It dropped the 'Manchester' from the title and called itself from then on the *Guardian*.

With the *News Chronicle* the publishers' evening paper, the *Star*, disappeared. Whereas in the early 1920's there were five London evening papers there are now only two left, although the population of the capital has increased by 50 per cent since then: a striking example of the financial concentration in the newspaper world, with vastly increased circulations for fewer papers. This means that the men who influence our opinions on the world's events leave us less and less choice as to the kind of paper available for us to read.

The man who many believe exerted the greatest influence on the pattern and growth of American newspapers was a Scot named James Gordon Bennett. Bennett studied in Aberdeen to be a Roman Catholic priest, but gave up his studies in 1819 and emigrated to America. He was then twenty-four years old.

With his small savings he brought out a two-cent morning newspaper, the New York *Globe*, on 29 October 1832. A month later it went out of business, swamped by its competitors. Bennett went to Philadelphia, where he was hired to edit a small newspaper called the *Pennsylvanian,* which also went bankrupt within a year.

In September 1833 a man named Benjamin H. Day shook the newspaper world in New York by publishing the New York *Sun* and selling it for one cent a copy, while most of his competitors charged six cents for their papers. The *Sun* was an instant success. Bennett approached Benjamin Day for a job on the paper. Day refused to hire him. *All right,* Bennett decided, *then I'll get out a penny paper of my own, better than his!*

Publishing a paper required money, and Bennett didn't have enough; so he wrote a flock of 'quickie' short stories and sold them until he had accumulated more than five

hundred dollars. Part of the money went to rent an 'office', which turned out to be a small room in a cellar at 20 Wall Street, New York. His office 'furniture' was not expensive—it consisted of two old flour barrels holding up a rough plank that Bennett used as his desk. The biggest expense was in getting the paper printed. All other jobs—proof-reading, editing, reporting, folding, selling, and bookkeeping—were done by Bennett, who was also advertising and circulation manager. This was the beginning of the *New York Herald* and a fabulous career.

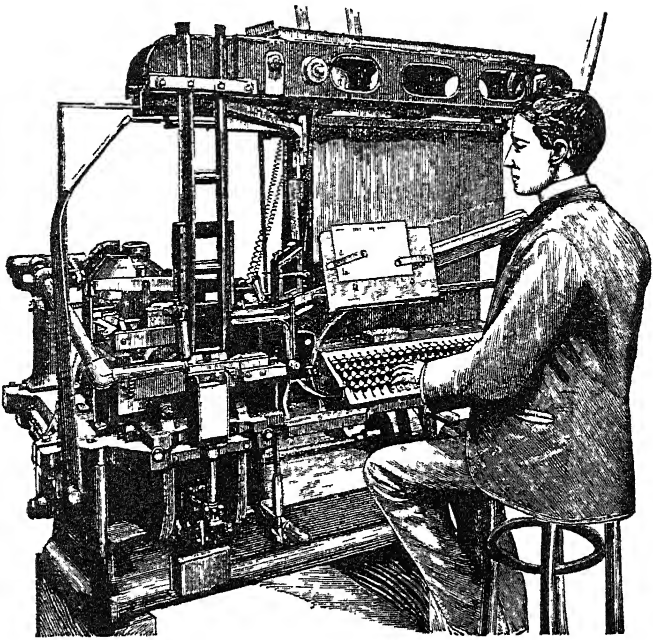
Bennett's *Herald*, a four-page paper, came out on 6 May 1835. The established six-cent papers called it 'penny trash'. Bennett proceeded to scrap the 'classical reporting' of news as published by his competitors. He invaded the police courts, recorded the 'juicy' proceedings of all kinds of human-interest cases, turned the spotlight on shady political dealings, bared the details in divorce cases, and in general printed news that was sometimes sensational, but always full of fascination for his readers. Editions of the *Herald* were sold out quickly and Bennett was soon in the newspaper business to stay. Later the *Herald* was combined with another paper, the *Tribune*, to become what is today one of the world's great newspapers, the *New York Herald Tribune*.

There are now more than two thousand daily newspapers in the United States alone, while Britain has the papers with the largest circulation in the world—the *Daily Express* prints 4½ million copies, the Sunday paper, *News of the World*, 7 million. In this and other countries the newspaper is a powerful influence in forming public opinion about politics, domestic and foreign policies, economics, and all other aspects of our lives.

In Bennett's day, and long afterwards, newspapers were printed from type set by hand. In 1885 a German-American watchmaker named Ottmar Mergenthaler patented a typesetting machine which was at least five

times faster than the fastest hand typesetter, and which revolutionized the printing industry.

Mergenthaler's machine had a keyboard similar to that of a typewriter. It held a supply of matrices, or moulds, for the letters of the alphabet, numerals, punctuation



Mergenthaler's Linotype machine.

marks, and blanks for spaces between words. When the operator depressed a letter on the keyboard, such as A, the machine would push the mould for the letter A on to an endless belt which carried it to a device called the 'assembler'. The operator would continue to press keys to select matrices for other letters; these would be carried along and placed in proper position beside the A until he had formed a sentence or part of a sentence, depending

upon the width of the column being set. For example, he might choose to set the words 'All were convicted'.

When the matrices were in place, they were automatically pushed in front of a narrow slot in a 'mould wheel' through which melted type-metal was pumped in to the moulds. The metal hardened into a 'slug' which was then separated from the matrices, forming a one-piece line of type with the sentence 'All were convicted' set in reverse, ready for printing. In this way a whole article could be set mechanically into a newspaper column.

When the matrices were separated from the slug they were automatically carried back to the 'distribution box', ready to be used again when needed.

When Mergenthaler's machine was perfected it was taken over by a publishing syndicate, which included Whitelaw Reid of the *New York Tribune* and Melville E. Stone of the *Chicago Daily News*, for three hundred thousand dollars. The first machine to be used for newspaper typesetting was installed at the *Tribune* in 1866. Mergenthaler himself set the first line of type; Reid set the machine in operation and gave it its name—the 'Linotype'.

For setting books the 'Monotype' has been found more satisfactory. It was invented by Tolbert Lanston from Iowa, who had served in the American Civil War and then became an official in Washington in the 1880's. The Monotype has two separate parts: a keyboard machine which perforates rolls of paper in certain patterns, each combination of holes representing one character, and a 'caster' in which the holes release matrices from which the characters and spaces are cast in metal, forming lines of predetermined length.

In our own times the technique of setting has made spectacular progress. One new invention is the Teletypesetter, which enables a Linotype to be operated by 'remote control'—over any distance, by wire or by radio waves. This is done by first typing the text on a tape-

punching machine, very much like that of a Monotype; it is these combinations of holes which are transmitted to a receiver, the 'reperforator', where the same patterns are punched into a tape. This is then fed into a Linotype, which works without a human operator.

An entirely new idea in printing is the technique of 'photo-composition' or 'film-setting'. Here, too, the start is made with punch-holes in rolls of tape; this is then automatically turned into characters on film or paper in a 'photo unit'. An electric-photographic machine, the 'composer', makes up the text matter; the operator can choose any type, from the smallest to the largest. The page is also produced on film or paper; then the pictures are inserted, and the page processed by the plate-maker for lithographic printing. The whole system requires few skilled operators, with a saving of about 40 per cent of production costs. By 1962 about 150 local papers and 450 weeklies in America had already gone over to photo-composition, and some papers in the British provinces and in the Commonwealth, troubled by financial problems, had begun to experiment with it.

8

MESSAGES ON WINGS AND WHEELS

IN THE early days of the *Herald*, Bennett contrived to get news from outlying points by every possible means. The railways, sailing ships, and canal barges provided good transportation but were slow. Remembering history and the stories of ancient Greek runners, Bennett set up a relay system of his own and used runners between New York and other cities; but this was still not fast enough. Then he heard about Daniel Craig and his pigeons.

Daniel Craig, a New England printer's apprentice, once considered publishing a penny newspaper in Boston. Instead, he set out to collect news and to sell it to publishers as a service.

Craig knew about Bennett's human runners, but he had also read ancient history and knew of another, faster way to send messages. The Sultan of Turkey, as long ago as A.D. 1150, had trained pigeons to fly long distances and to come back to their 'homes', or lofts, carrying official messages in a small capsule attached to one leg. King Solomon and the Queen of Sheba exchanged notes by carrier pigeon about 1000 B.C. During the political upheavals of 1849 a former German bank clerk, Julius Reuter, sent news items from Aachen to Brussels by homing pigeon—before he settled in London to found the first great news agency. Why not use pigeons as messengers in America? thought Craig, and ordered several of the

birds from Europe, along with instructions for breeding and training them.

Once accustomed to their lofts, the birds were taken farther and farther away from the city and released while Craig watched them head for home. The birds could fly as far as six hundred miles in a day, at speeds of forty to sixty miles an hour. When his 'pigeon post' was ready for business he sent a friend and some of the birds several miles out to sea in a small boat to meet America-bound sailing ships from foreign ports. The friend, acting as a reporter, would board the ships, interview officers and passengers, get any important news, condense it into as few words as possible, put his notes in capsules on the birds' legs, and send them winging towards Boston. In Boston, Craig met the flying messengers, wrote news stories based on the notes they carried, and sold the stories to editors of the Boston newspapers.

In a few months Craig's pigeon service was extended to New York City; and when James Gordon Bennett saw that editors of rival newspapers were getting some news long before he did, he made inquiries and learned about Craig's pigeon post.

Bennett promptly talked with Craig and made a deal whereby Bennett would have fifty or more pigeons trained and would then have Craig hold his birds to be flown with news for the *Herald*. Since other New York papers were getting news the same way, Bennett agreed to pay Craig five hundred dollars for every hour that a bird would reach the *Herald* before others touched down at competitors' lofts.

Messages carried by pigeons were necessarily brief, because the bird could not be weighted down without hampering its flight. In ancient times, when armies used pigeons (as they still do), it was customary to write military messages in code, not only to shorten the messages but also to safeguard the information in case the bird should be captured by the enemy.

For centuries man has devised codes and ciphers to send secret messages, and all governments today use elaborate methods to protect important confidential information against reaching their enemies.

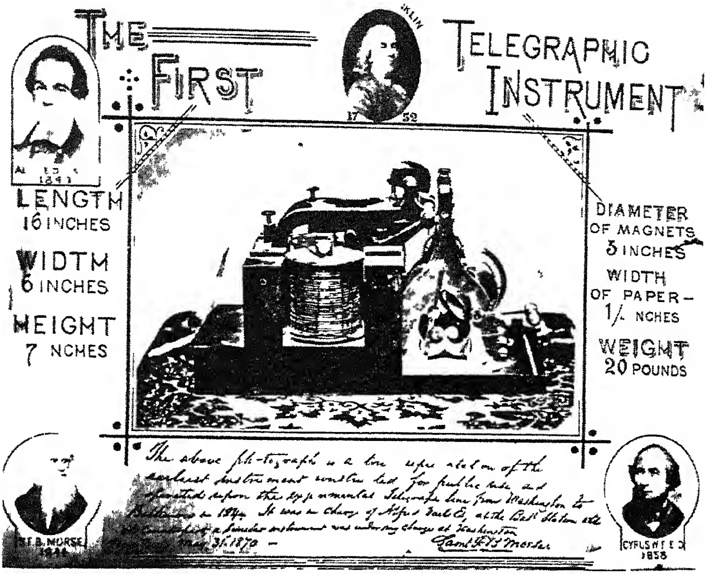
Cryptography, or the science of hidden writing, was used by the ancient Spartans and others before the time of Christ. Plutarch has described the Spartan method of using a *scytale*, or staff, for composing and deciphering a message. A strip of parchment was wound in a spiral around the staff and the words were then written on the adjoining edges of the parchment. When the parchment was unwound the words were meaningless, but when it was delivered to its destination the receiver had a staff exactly like the one that was used in writing the message. By wrapping the parchment around the staff in the same way, he could instantly read the words without difficulty.

Occasionally the Jewish sacred writers used a code system called 'atbash', in which they substituted the last letter of the Jewish alphabet for the first, using the alphabet backwards. In the Bible (Jeremiah xxv. 26) a reference to the 'king of Sheshak' means 'king of Babel [Babylon]'. The second and twelfth letters of the Jewish alphabet, as in our own, are B and L, but Jeremiah took the second letter from the end (Sh) and the twelfth letter from the end (K). Thus, instead of the sounds 'B-b-l' he used 'Sh-sh-k'.

One ingenious method of sending secret messages was employed by the Greek Histiaeus, who had to communicate secretly with his son-in-law, Aristagoras. He shaved all the hair from the head of a trusted slave, tattooed a message on the scalp, then let the hair grow back and dispatched the slave on his journey from Persia to Greece. At his destination the slave, as instructed, said to Aristagoras, 'You are to shave the hair from my head and read what you find there.' The message was as clear as the day it was needled into the slave's skin. Even in our own time spies have invaded enemy territory carrying messages written on various parts of their bodies in invisible ink.

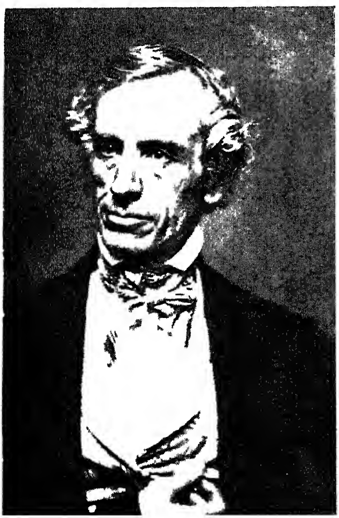
The joining of the Union Pacific and the Central Pacific Railways, 10 May 1869.

The first regular airmail flight, between New York, Philadelphia, and Washington, 15 May 1918.



The first Morse telegraph instrument used commercially in 1844

LEFT Samuel F B Morse RIGHT Lee DeForest, inventor of the audion tube



Today there are many ways to send coded information: a simple numerical method, in which a number represents a letter of the alphabet; a substitution method, in which certain letters are chosen to stand for other letters, for instance, letting the letter E represent the beginning of the alphabet, or A, so that F would be B, and so on; using letters arranged in certain geometrical patterns; and various other methods. Most national governments, however, now have complicated electronic machines to encode and decipher secret writings, although most experts believe that there is no code or cipher which cannot be unravelled in time.

Time is often of the utmost importance in communication. Consider the man who may be shipwrecked and washed ashore on a tiny island in the middle of the ocean. He manages to find a bottle, pencil, and paper, and writes a plea for help which he places in the bottle, tossing it into the sea. If it reaches a ship or the shore and is found in time, his life may be saved. If not . . .

In 1784 a Japanese treasure-hunting ship ran headlong into a Pacific coral reef and sank. Her forty-four treasure-hunters managed to get to the reef, but they had no food or water and eventually they all starved to death. The story is known only because one of the men carved it on a strip of wood which he stuck in a bottle, throwing it into the sea. The bottle bobbed around the wide Pacific for 151 years, finally washing ashore in 1935 at Hiratatemura, the Japanese fishing village where the writer of the message had been born!

Benjamin Franklin used sealed bottles to study the course and speed of the Gulf Stream. The United States Navy has for years set bottles afloat carrying printed forms in several languages, asking finders to write in the time and place where any bottle was found. More than three hundred answers a year are received, and the information is valuable in preparing charts of ocean currents for navigational purposes.

If you live near the sea and want to try this method of communication, simply put a note in a bottle; be sure the bottle is securely sealed and throw it into the water as far from shore as possible. Your note might ask anyone who finds it to write to you. Who knows? You may get an answer from an Eskimo!

Letters have carried news since man first learned to write, and today we have regular postal systems which permit us to send and receive correspondence to and from all parts of the world. Some day mail will perhaps be shot across the world by rocket, climax to an adventurous postal story that began long before the Christian era.

The first 'mail' consisted of messages scratched into clay tablets which were entrusted to runners to be carried across the country. About 3800 B.C. King Sargon of Babylon sent 'letters' in this manner; and in the clay of each tablet, before it was baked, he placed an impression of his royal seal or crest.

On some occasions the runners merely memorized the messages that were to be delivered, and had no heavy tablets to carry. However, if they expected to run through areas in which robbers were known to be active, the runners sometimes carried homing pigeons, and if they were about to be attacked they would release the pigeons. When the birds returned home, other runners were sent out with the same messages.

In the fifth century B.C. Herodotus, the Greek historian, wrote about men on horseback carrying messages inscribed on bronze tablets. From Herodotus came the inscription now chiselled into the stone above the main entrance to the post office in New York City: 'Neither snow, nor rain, nor heat, nor gloom of night stays these couriers from the swift completion of their appointed rounds.'

In a letter to the Roman emperor Trajan, written about A.D. 100, Pliny the Younger said, 'I am informed by a letter from the King of Sarmatia that there are certain affairs of which you ought to be informed as soon as

possible. In order, therefore, to hasten the dispatches which his courier was charged with to you, I granted him an order to make use of the public post.'

The 'public post' was not a true description of the service, because the system was used primarily by the rulers and the rich; and it was not until about A.D. 300 that the first postal system for use by the public was established in a limited way in Rome by the Emperor Diocletian. Messages were carried at irregular intervals by young men who ran in relays; but these runners later gave way to men on horseback, an early version of America's Pony Express.

In 1464 a system was begun whereby men carried messages regularly. King Louis XI, tyrannical ruler of France, appointed a group of 'King's Couriers' who carried golden horns to announce their arrival, and warned the population that anyone who dared to delay or injure one of these men would be jailed, tortured, or killed. King Louis restricted the use of his regular postal service to high officials of his court, and more than fifty years passed before the ordinary citizen in Europe could send letters by courier.

Regular postal service in Germany began in 1520, but even then the cost of sending a letter was so great that the customers were mostly people of wealth. The first Postmaster General in the German Empire was Prince Taxis; his family, the Thurn und Taxis, held that hereditary post from the sixteenth to the nineteenth century.

The idea of a postal service began to spread, and in 1523 Henry VIII organized a postal system for royal use. It was later made available to the public, and during the reign of Queen Elizabeth I it was common practice for people to write on the outside of their letters the words, 'Haste, Post, Haste, for Thy Lyfe, for Thy Lyfe, Haste' as a reminder to the 'postboys' to speed their transmission. Once in a while someone who was really in a

hurry would draw a skull and crossbones alongside the inscription—a veiled threat to ensure 'express delivery'!

The 'postboys', with their post horns, carried the mail in saddlebags on horseback. Each was required to blow his horn four times in every mile and to ride at a speed of seven miles an hour in summer, five in winter. The 'postboy' system of mail delivery was in use in England for more than two hundred years.

Thomas Randolph, 'Master of the Queen's Post' under Elizabeth I, was responsible for the organization of an efficient relay system for post-horses. Each horse travelled twenty miles, and towns on the route were expected to have fresh horses ready as needed; the towns situated on the main postal routes, such as London–Dover or London–Bristol, were so often ordered to supply horses that even ploughing was delayed, and in the end the citizens found it easier to pay the Post enough money for providing its own horses. The post-horses for the City of London came from Hackney, then a few miles outside the town, and when they were not carrying mail they could be hired out to anyone who could pay for them: this was the origin of the term 'hackney carriage'—and even today a London taxi is still legally known as a 'hackney carriage'!

Apart from the royal post in Queen Elizabeth I's time, which was mainly carrying official letters, with only a few private ones in between, there were also a number of unofficial letter-carriers. Payment for letters by the official post was arranged between the carrier and the person who received the letter, but the carrier was supposed to hand the fee to the Master of Posts.

By her proclamation of 1591 Queen Elizabeth I laid down that letters must not be sent out of the country except by official carriers, and made it an offence to send a letter abroad by private messenger; this was a safeguard against the exchange of letters intended to encourage rebellion against the queen, and all letters were first read

by what we would now call censors. The idea of the postal secret was not yet born. But it was difficult to enforce the Act, and the 'Merchant Adventurers', who carried on foreign trade, had their own posts.

By an Act of 1609 King James I attempted again to establish the Crown's monopoly as letter-carrier, but the Merchant Adventurers were then so powerful that they could afford to ignore the law. However, the King's Master of Posts did much to improve the inland postal services, for which he imposed a fixed charge, and established the first 'packet'—a postal service by boat across the English Channel.

In spite of the Civil War in the 1640's, it was during the first half of the seventeenth century that the Post Office really became a public service. Under Cromwell, Captain John Manley was appointed Master of the Posts; he paid £10,000 a year for his appointment, for Cromwell gave him power to stop all mails carried by unauthorized messengers. But many people supported the carriage of mails by private carriers as a matter of principle. There was a long feud between the official and the private posts before the Government finally succeeded in suppressing all mail services except its own. In 1657 Cromwell created the office of the Postmaster General, and when Charles II ascended the throne three years later he passed a new Act which more or less confirmed Cromwell's.

Successive Postmasters General improved the service. Postmarks with the date of acceptance were introduced 'to prevent any neglect of the Letter-carryers in the speedy delivery of Letters'. Even a kind of self advertisement was introduced—one of the postmarks, for instance, bore beside the date the slogan, 'Essex post goes and comes every day'. The first postal 'branch offices' were established in the 1660's: five 'receiving houses' in London between Westminster and Fleet Street. The Great Plague played havoc with the postal services; out of London's

forty-five employees, thirty died of the dreadful disease. After the plague came the Great Fire, during which several postal offices were burnt down, and postal headquarters changed a few times.

In 1680 the Government's postal monopoly was challenged by a postal 'pirate', William Dockwra. 'Searchers'—Government detectives appointed to discover the smuggling of letters—found that he operated a flourishing 'penny post' in London, defying the Postmaster's rights. He had appointed no fewer than 400 or 500 'receivers' at whose houses letters could be deposited, and from which messengers collected them every hour. The letters were taken to distribution centres; parcels were also accepted, and there was even a system of registration as an insurance against loss. After the receiving houses closed at five o'clock in the afternoon the letter-carriers walked through the main streets for an hour and a half, ringing a handbell, and people came out from their houses to put letters in the carriers' bags.

After two years, in which Dockwra made a considerable profit, the Government intervened. But Dockwra fought back with his lawyers. He succeeded in getting a pension under William and Mary—and ended up by being appointed Comptroller of the Penny Post Service! The London Penny Post, by which one could send a letter from one end of London to the other for 1*d.*, continued for over a century and a half; and by 1840 public pressure for a cheap postal service became so great that the penny post was extended throughout Britain.

There were stage-coaches already in the seventeenth century, but the Post Office was reluctant to use them for mail transport. It was only with the help of William Pitt the Younger that the Government were finally persuaded to run a special coach for mail which did not have to pay the usual tolls at the turnpikes. The roads were unsafe for lonely travellers, and the postboys were often attacked, robbed, and even murdered; so when the first mail-coach

started in 1784 it was hoped that the postal service would now become not only quicker but also safer. This first mail-coach ran between London and Bristol; it travelled the distance of nearly 120 miles in sixteen hours, and the experiment was so successful that within a short time postboys were replaced by coaches on all the mail routes.

Each evening between 8 o'clock and 8.20 the mail-coaches lined up outside the General Post Office in Lombard Street—an impressive sight which Londoners never tired of admiring. The mail was loaded in the boot. The guards and coachmen, armed with pistols, mounted the coach-box, and off they went on their separate journeys. This scene was also an advertisement for journeys by mail-coach, and it is said that the highwaymen left the coaches with their armed guards well alone.

However, this picturesque era of the postal service was a short one. By 1830 a new means of transport was ready to serve first England and soon the whole world—the railway.

The first railway in the world to run from one town to another grew from the idea and invention of a young man who could neither read nor write. George Stephenson, born 9 June 1781, in Newcastle-on-Tyne, did not go to school as a boy. He earned money by preventing cows from straying on to the track of a horse-drawn colliery railway.

At the mine, where he began to work as a coal sorter at the age of nine, young George was so interested in the steam-pumps that he began to make small models of the engine and to study its operation, and the mine owners finally hired him to keep the machinery in good working order.

By the time he was eighteen years old George decided that he still had a great deal to learn about steam-engines and that the only way to do so was to read books on the subject. Since he was illiterate he had to go to school at

night to learn to read and write. His progress was swift, and within a few years he was reading all the books about machinery that he could find.

One of the machines that interested Stephenson more than the others was an engine that had been made by a Cornish engineer, Richard Trevithick: a steam-driven engine with wheels that would move on rails. Trevithick at one time built a circular track at Euston, London, and charged admission for people to take rides on the new-fangled merry-go-round. The engine had certain faults which George Stephenson hoped one day to eliminate with a superior 'travelling machine'.

Stephenson was in charge of pumping and other machinery at another coal-mine when his employers asked if he could build a steam-engine that would haul coal from the pit-head to the canal. He built a small engine that did the job, followed by others on which he made improvements, and when his work became known he was employed by other mine owners to build similar equipment for them.

When Stephenson was forty years old he heard that a man named Edward Pease was going to build a railway between Stockton and Darlington, using horse-drawn cars. Stephenson went to see Pease.

'Instead of using horses to pull your train', Stephenson said, 'why don't you use steam-engines? They are much faster and more powerful.'

Mr Pease smiled knowingly. 'That may well be', he said, 'but will they work?'

'Why don't you come and see for yourself? If they'll haul heavy loads of coal, they'll carry people.'

Pease visited the mine, saw the engine in operation, and engaged Stephenson to build the railway. Stephenson spent most of his life's savings to set up a workshop and buy equipment. Rails were made and laid, and he designed and built his locomotive. On 27 September 1825 the engine was hooked up to twelve wagons loaded with

flour and coal, and twenty-one wagons with seats for passengers. Crowds of curious people lined the tracks, many expecting that Stephenson's engine would sputter and give up—but it didn't. Stephenson himself drove it at the unheard-of speed of twelve miles an hour as the people cheered and whistled.

This was the first passenger-carrying train pulled by a steam-engine; and it was the beginning of an industry that was to build networks of steel rails over most of the whole earth, bringing peoples closer together, expanding trade and commerce, and making communication easier and faster than ever before.

The next great venture was the construction of a long railway line for passengers and freight from one large town to another—from Liverpool to Manchester. There was a long struggle in Parliament, which was in the end won by Stephenson and his friends; many people feared that such a new means of transport would endanger passengers' and onlookers' lives. But the railway proved to be safe and efficient. It was opened in September 1830, with Stephenson's famous 'Rocket', which had won a race against other engineers' locomotives.

In the New World railways were found to be even more important than in Europe, for the development of the United States depended on communication across vast spaces of virgin territory. Little by little the American railroads extended their tracks, both East and West, until the historic moment on 10 May 1869 when rails from the East were joined by those from the West at Promontory Point, Utah—the first transcontinental railroad was completed. Soon there would be branch lines extending north and south, and the day of the mail-carrying stage-coach would be over.

Years later, in 1911, another milestone in mail delivery was reached when a small aircraft took off from a flying field outside Mineola, New York, with a load of letters which were delivered a short time later to the Mineola

Post Office. After many experiments the first regular airmail route was established in 1918 between Washington, D.C., and New York City, a distance of 218 miles. A year later the first regular passenger service was established between London and Paris, and an airmail service between England and Belgium.

Ships today carry an 'International Flag Code' and a supply of signal flags. A Japanese vessel, wanting to communicate with a French ship at sea, can raise certain signal flags which the French captain can 'read' by referring to his flag code, and he can reply so that the Japanese skipper will understand in the same way.

Signal systems with flags had been used for scores of years, but in 1790 a Frenchman named Claude Chappe conceived the idea of attaching movable bars, or arms, to the top of a long pole and, by means of ropes, moving the arms up or down to different positions to represent letters of the alphabet. At first Chappe used his device, the semaphore, to communicate with his brothers at a school more than a mile away.

However, after the French Revolution, the French Government became interested and a semaphore line was erected along the 150 miles between Paris and Lille. Tests proved that signals could be sent from one end of the system to the other within two minutes.

The French built semaphore stations in all directions out of Paris, and other European countries soon began to copy them—so that Chappe's invention was in wide use until 1850 or thereabouts.

Then, however, a more modern system of signalling had already begun to conquer the world.

9

THE PHANTOM MESSENGERS

THE PEOPLE of the Congo in Africa send messages with a jungle tom-tom, or drum, that virtually talks.

The Congo people, and others in Africa and Asia, have a peculiar way of speaking; certain syllables and words are uttered in low tones and others in high tones. In these 'tonal' languages the sounds have a different meaning when they are uttered at a different pitch. To imitate the low and high pitch, the natives dig out a log until they have a hollow cylinder about five or six feet long and perhaps two feet in diameter. In the hollowing process, however, one side of the cylinder is purposely left thicker than the other. The ends are covered and a long narrow slit is cut lengthwise in the log. With the cylinder placed firmly on the ground, or upon a rigid framework, a native drummer pounds it with two heavy sticks, one in each hand. By hitting the thicker side of the drum he produces high tones, lower tones on the thinner side of the slit. The sounds resemble those in the native dialect.

In sending a message the operator raps the cylinder with the sticks so fast that the sound seems to be merely rapid drumming, but to a person familiar with the language the drumbeats actually 'speak' words and can be heard for some distance. By relaying the sounds from one drummer to another messages can be sent for many miles.

American Indians also used skin-covered tom-toms to

communicate. Tribes had different meanings for long or short drumbeats, but all tribes used the drums to keep in touch with their people in distant villages.

One of the most unusual methods of sound communication is still found on Gomera, one of the Canary Islands, some sixty miles west of the African coast. Gomera, like some of the other islands, has extremely rugged and mountainous terrain, making travel very difficult. Its Spanish-speaking people, therefore, have for years communicated with one another across great abysses and ravines by whistling from the hills. The Gomerans have actually developed a Spanish vocabulary in whistling tones, used effectively even by the children. The shrill whistled notes carry clearly and are not only readily understood but also pleasant to hear.

In his constant search for better and faster ways to communicate by sound rather than sight, man has used other unique methods. Cyrus the Great, founder of the Persian Empire, built a series of towers and posted a man on each. The man was chosen for the power of his voice; and when the king wanted to send a message it was delivered to the man on the first tower, who shouted it through a megaphone made of animal skins—so that it could be heard and relayed by the man on the next tower.

From the history of Greece comes the story of a herald in the Trojan War whose voice was louder than the voices of fifty men together! His name was Stentor, and we still describe a loud voice as being 'stentorian'.

When Charles II sought a new way to transmit the spoken word over long distances, Sir Samuel Moreland in 1670 built a huge curved megaphone, or horn, about twelve feet long, perhaps four inches in diameter at the speaking end and eighteen inches or more at the outlet. By shouting into this contraption, which he called the *Tuba Stentorophonica*, Moreland succeeded in transmitting understandable sentences to King Charles nearly two miles away.

There is a legend that Alexander the Great (356–323 B.C.) once had a megaphone built of such dimensions that it carried his voice for a distance of twelve miles! The word *megaphone*, incidentally, comes from the Greek *megas*, meaning 'great', and *phonē*, 'voice'.

Long before Alexander the Great—about 600 B.C.—the Greeks discovered a phenomenon which was later to change the world, but which to them was merely an interesting curiosity. They found that if a piece of amber were rubbed vigorously with the fur of a cat or other animal and then placed near some dust or fibre, the dust or fibre would cling to the amber. They did not know that they were creating a magnetic action by friction, although centuries later the whole world would be familiar with the Greek word for amber—*elektron*. Objects other than amber had similar powers of attraction when rubbed and were said to be electrified, or charged with electricity.

The first electricity-making machine was made about 1650 by Otto von Guericke, Burgomeister of Magdeburg, Germany, who designed it after he had produced an electrical charge in a sulphur ball by rubbing it with his hands, just as we can charge our bodies by rubbing our feet vigorously on a thick rug. Later experiments by other scientists showed that electricity could be made to travel along a wire or some other metal conductor.

In the eighteenth century several men tried to use electricity to transmit signals that could be translated into messages, but their methods were not practical. In October 1832 an American portrait painter named Samuel Finley Breese Morse was returning to the United States from France aboard the packet ship *Sully* when he took part in a conversation that was to inspire one of the greatest inventions of all time—the telegraph.

During the crossing one of the passengers entertained the others by repeating some experiments he had seen Professor Ampère demonstrate in Paris—experiments with an electromagnet, a piece of soft iron around which a coil

of wire had been wound. The iron became a temporary magnet when current was sent through the wire coil.

This suggested to Morse that a series of signals could be sent over a wire by starting and stopping the current, and he immediately began to sketch plans for an electric signalling device.

Morse, who had been a successful portrait painter, devoted himself entirely to this invention. Soon he had barely enough money to support himself and none with which to buy equipment to test his idea or to build a model. In 1835 he won a post as Professor of the Literature of the Arts of Design at New York University, which paid him a small salary and gave him a chance to experiment. In a garret in Washington Square he built a crude telegraph, using an old easel, a clock, and a length of wire which he had laboriously wound by hand around a piece of soft iron. The instrument was big and cumbersome; but it showed Morse that it was possible to turn the iron into a magnet so that it would attract its armature—another piece of iron—so long as the current was in it. Attached to the armature of the magnet was a pencil which would make a mark on a moving strip of paper unrolled by clockwork. If the current was cut off quickly the pencil would merely make a small dot. If the current was maintained the pencil would stay against the moving paper and make a line, or dash. By creating a system of dots and dashes to represent letters of the alphabet, Morse could spell out any message on his device.

Even as Morse conducted his experiments, another inventor, Joseph Henry, was testing a magnetic telegraph system which he developed while he was a Professor of Natural Philosophy at Princeton University. But the outcome of Henry's experiments was—the electric bell!

With the material and financial help of a student, Alfred Vail, who later became his partner, Morse built improved models, and in 1837 they gave a demonstration showing that messages could be sent across the hall of

New York University. The audience was amazed, and Morse's 'contraption' became the talk of New York.

Morse wanted the Federal Government to finance the building of a telegraph line between Washington and Baltimore to prove the value of his invention. Members of Congress ridiculed the idea. Some called Morse a fool; some branded him a maniac; others said his invention was a farce; and the General Postmaster opposed the invention because he feared that it would mean the end of the letter post. For five years Morse ignored them all and continued his struggle to gain the support of Congress.

On 3 March 1843 a Bill was introduced in the Senate to provide Morse with thirty thousand dollars to build his telegraph line. March 3, however, was the very last day of the session, and this Bill could not be reached until 119 others had been acted upon. All morning and into the late afternoon Sam Morse sat in the Senate galleries hoping and praying that his Bill would come up for consideration. By sundown the Senators were still making speeches about other legislation; many Bills were yet to come, and Morse left the galleries in deep despair. He was certain his Bill would die and that he would have to begin his fight all over again.

At his hotel he packed his suitcase and left for New York by the night train. In the morning he was having breakfast and was visited by a young friend, Miss Annie Ellsworth, daughter of the Commissioner of Patents.

Smiling broadly, she shook his hand and said, 'I've come to congratulate you, Mr Morse.'

'For what?' he asked.

'Why, upon the passage of your Bill, of course.' She continued to grin.

Morse shook his head. 'It isn't possible', he told her. 'I was in the Senate all day and they were still talking about other things last evening. I'm sorry, Annie, but you're mistaken.'

'No such thing! Father stayed until the close of the

session late last night, and your Bill was the very last to be considered. It was passed, and I begged to be the first to bring you the news.'

Morse took Annie's hands in his own and laughed as he thanked her over and over again. 'You know something?' he said. 'As a reward for being the first bearer of this wonderful news, you are going to send the very first message over our telegraph.'

The telegraph was completed in May 1844, with lines extending from the Mount Clare Depot in Baltimore, Maryland, to the Supreme Court Chamber, then in the Capitol at Washington. When all was ready for transmission, Morse sent for Annie Ellsworth and her message. Annie handed him a paper on which she had written four words: 'What hath God wrought.' This was the first telegram sent from Washington to Baltimore over the first public telegraph line in the world.

When the line formally opened for business, receipts for the first four days amounted to one cent! A customer in Washington strolled in on the fourth day. 'I'm curious to see your contraption work', he said.

'Do you wish to send a message?' the clerk asked.

'No. I just want to see it work.'

'I'm sorry. I can't operate the key except to send a message.'

'Hmm. How much would it cost?'

'One half-cent a character.'

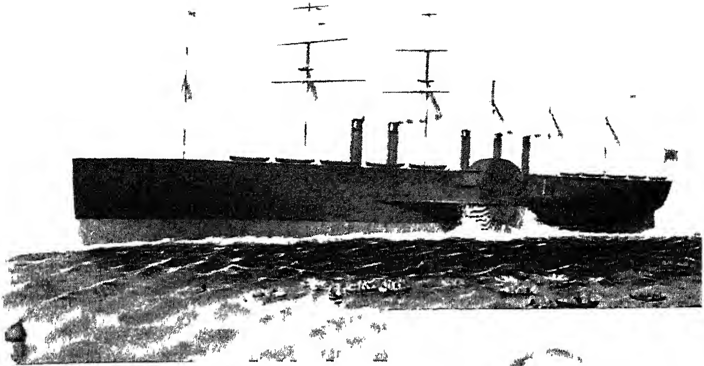
The customer drew a coin from his pocket and handed it to the operator. 'All right. Send two characters for me.'

The clerk scratched his head, grinned, picked up his code book, and tapped out a two-symbol signal for 'What time is it?'

The answer clicked back: 'ONE.'

The customer was satisfied.

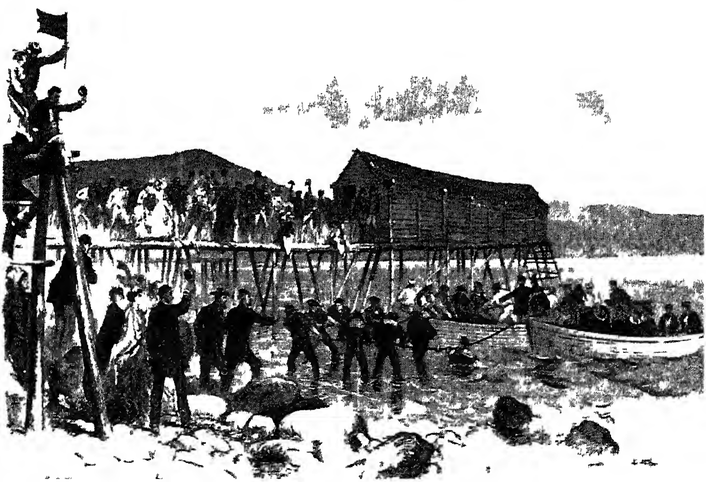
Morse's telegraph, however, was not the only one to be tried out successfully, but his system proved more practical and efficient than that of his rivals. As early as 1753 the

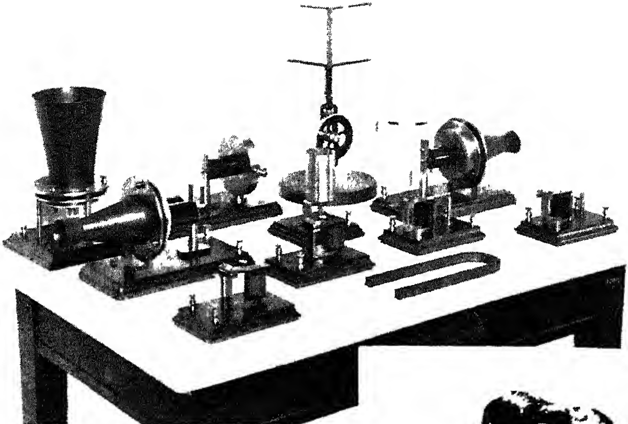


ABOVE. The iron steamship *Great Eastern*, which succeeded in laying the first transatlantic undersea cable.

RIGHT Cyrus W. Field.

BELOW. Hauling the end of the Atlantic cable ashore at Heart's Content, Newfoundland

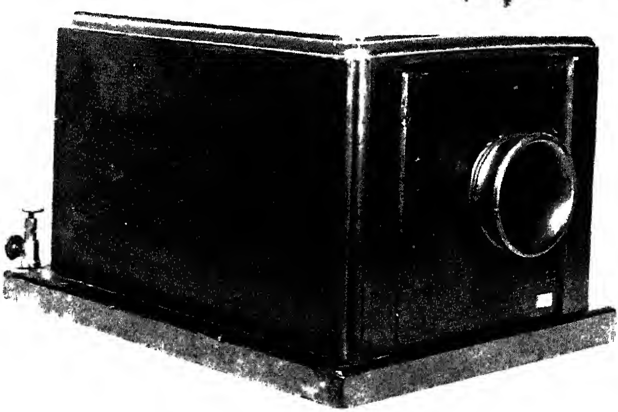




ABOVE. Bell's telephone exhibit at Philadelphia Centennial Exposition, 1876.

RIGHT. Alexander Graham Bell.

BELOW. The first commercial telephone, 1877.



Scottish physician Charles Morrison had suggested the transmission of signals by electricity. The discovery of the deflection of a magnetized needle by the electric current, made by Professor Oersted in Copenhagen in 1819, prompted two scientists at Göttingen, Germany—Weber and Gauss—to use this method for the transmission of signals. They built a telegraph line over the roofs of the town from the observatory to the physics laboratory, a distance of over two miles, in 1833. It worked, but the sending of messages by means of needle deflections was rather slow.

A few years later another physicist, Steinheil, built a telegraph with two magnetized needles in Munich; he made them print little dots on a moving paper band. A scientifically minded diplomat in the Russian service, Baron Schilling, demonstrated a five-needle telegraph at a congress in Bonn in 1835; somehow the model got to Heidelberg, where a young Englishman—later known as Sir William Cooke—was studying medicine. After his return to England, Cooke teamed up with Sir Charles Wheatstone, professor at King's College, London, to improve Schilling's system.

Their telegraph also worked with five needles, arranged on a lozenge-shaped panel with the letters of the alphabet and the numbers from 0 to 9 on it; the positions of the needles indicated the transmitted letter or number. With this system the two scientists opened the first telegraph line in England—only a few weeks after Morse had completed his line from Washington to Baltimore. Cooke's and Wheatstone's line, with five wires, extended along the London–Blackwall railway, and it was so successful that the Great Western Railway had a nineteen-mile line installed from Paddington station to Slough. Posters invited the people of London to send messages, or at least to watch the operation of the telegraph (at an admission fee of 1*s*.), but interest in this new 'wonder of the age', as the posters called it, was weak. A short while after the

opening of the line, however, something happened which made the telegraph the talk of London.

On 1 January 1845 the operator at Paddington received this telegram:

a murder has just been committed at salthill and the suspected murderer was seen to take a first class ticket for london by the train which left slough at 7.42 a.m. he is in the garb of a kwaker with a brown greatcoat on which reaches nearly down to his feet he is in the last compartment of the second first class carriage

The operator at Paddington could not make out what was meant by 'kwaker', and sent a query to Slough; the answer was that 'kw' stood for the letter 'between p and r'—there was no 'q' on the panel with the five needles. Thereupon the operator hurried to the nearest police station and told the officers what the message said. When the train arrived at Paddington, plain-clothes policemen were already waiting for the 'kwaker'. They followed him across London on a horse-bus and eventually arrested him.

His name was John Tawell, and his trial was the sensation of 1845. He confessed and was executed, and the people of London said: 'Them cords'—meaning the telegraph wires—'have hung John Tawell!'

Cooke and Wheatstone managed to improve their telegraph so that it eventually worked with only one needle. The system survived for an astonishingly long time; there were still some Cooke-Wheatstone telegraphs working right into the twentieth century! Everywhere else, however, Morse's system achieved complete victory, much helped by the invention of the letter-printing telegraph by a London-born Kentucky music professor, David Edward Hughes, in 1854. Sir Charles Wheatstone, too, contributed a most important invention in 1867, permitting high-speed automatic transmission of telegrams with the help of punch-hole tape. This meant that up to 300 words per minute could be sent and received.

Progress in electronics has eliminated the hand transmission of commercial telegrams by the original Morse code of dots and dashes, and modern machines speed impulses over the wires so that letters typed on a teleprinter in one city are instantly reproduced on a similar machine miles away. In December 1959 Western Union began operation of a 'facsimile communications system' between Washington, New York, Chicago, San Francisco, and Los Angeles. This system, using an electronic-eye scanning device, can send the image of a letter or other message written or printed on a sheet eight and a half by eleven inches within six minutes.

The International Morse Code, however, is still used all over the world, especially in radio communication. Here it is:

A	· –	N	– ·
B	– · · ·	O	– – –
C	– · – ·	P	· – – ·
D	– · ·	Q	– – · –
E	·	R	· – ·
F	· · – ·	S	· · ·
G	– – ·	T	–
H	· · · ·	U	· · –
I	· ·	V	· · · –
J	· – – –	W	· – –
K	– · –	X	– · · –
L	· – · ·	Y	– · – –
M	– –	Z	– – · ·

The Morse code was useful in the operation of another kind of telegraph—a device which reflected the rays of the sun and was called the 'heliograph'. For hundreds of years ancient peoples used glass or polished metal to reflect the sun's rays to transmit signals; but the invention of a mechanical device that could be opened and closed rapidly is credited to an Englishman, Sir Henry

Christopher Mance, who was superintendent of the Persian Gulf Telegraph Department of the Government of India in the mid nineteenth century.

By using shutters to admit or keep out light, the heliograph could transmit messages in the dot-dash Morse code. It was and is still highly useful in war-time, especially aboard warships, where audible messages are sometimes forbidden. A powerful electric light in the device makes it unnecessary to depend upon sunlight for transmission.

After his telegraph line was in active operation, Morse explored the possibility of sending messages along wires strung under water. In October 1842, with a friend rowing his boat, he sank a long cable from Battery Park at the lower end of Manhattan to Governor's Island, New York. A few messages were sent over this wire, but the cable was accidentally caught on an anchor being hauled in by a ship in the harbour and Morse did not renew his experiments. He knew, however, that the idea was sound.

Submarine telegraphy began in earnest when the first cable was laid under the Channel, between Dover and Calais, in 1851. Many people looked upon this as a highly doubtful venture, and some fishermen who hauled up the cable by mistake when it was being laid caused a major problem by hacking it to pieces—in the belief that they had caught some unknown kind of eel, or even a sea serpent. They were rather surprised to find that the odd fish had a 'golden' spine (which, of course, was the copper wire inside the insulation).

After these and other complications had been ironed out, the cable was found to work very well indeed, and every London paper now had a special continental news column headed 'By Electric Telegraph'. In fact the telegraph had really begun to bring the nations closer to each other, to hasten the pace of events by making news known almost simultaneously in every country, to create the basis of what idealists hoped would become 'One World'.

The initial technical hitches of the cross-channel cable made it necessary to call in a competent scientist. He was found in the person of twenty-seven-year-old, Belfast-born William Thomson (later Lord Kelvin), a brilliant physicist whose special interest was the electric telegraph.

A few years later an American business man, realizing the tremendous importance of fast communication between the United States and Europe, set out to lay a telegraph cable across the Atlantic Ocean. His name was Cyrus W. Field, and the obstacles and disappointments that were to plague him might well have discouraged a less persevering pioneer.

Cyrus Field, with his English friends John Brett and Charles Bright, organized a firm called the Atlantic Telegraph Company in October 1856, and set out to raise money for laying the submarine cable. Funds were contributed by private investors and also by the United States and British governments, and Field's dream began to take on reality. Again Professor Thomson was asked to give his help and advice, and he was appointed a director of the new company.

The first great task was the making of the more than twenty-five hundred miles of cable. Contracts were made with three different companies at a total cost of about a quarter of a million pounds. After several trials and tests it was agreed that the cable would have a core of seven copper wires twisted around one another spirally and covered with three coatings of rubber-like gutta-percha. Hemp cord, dipped in tar, was wrapped around the gutta-percha; and the whole was then covered with eighteen strands of iron wire, each strand consisting of seven separate wires twisted together.

One-half of the length of the cable was placed aboard the battleship H.M.S. *Agamemnon* and the other half aboard the U.S.S. *Niagara*, a United States Navy frigate. The European land end of the cable, armoured for protection from the rocks, was installed near Valentia Bay in

Ireland, and from that place the *Niagara* headed out to sea on 6 August 1857, paying out her half of the cable as she sailed. The *Agamemnon*, with Thomson on board, was to meet the *Niagara* in mid ocean, splice the cable, and sail on to Newfoundland with the remaining half.

The cable, carefully arranged in an enormous coil in the ship's hold, was hauled up through a guiding slot and over grooved wheels, revolving drums, and a braking device—all designed to prevent any violent backlashing or jerking that might snap the wire as it slid beneath the waves at the vessel's stern.

Aboard the *Niagara* there was an air of terrific tension as Cyrus Field and the ship's crew watched the great cable snake its way up out of the hold and into the sea. There was little conversation, and some of the sailors even spoke in whispers. Lanterns and torches shone on anxious faces night after night as the wheels kept turning, turning, turning, mile after mile, and many crew members sacrificed sleep to do their share to ensure success.

It may have been this lack of sleep and sheer exhaustion that brought about disaster. After eleven days under way and after 335 miles of cable had been paid out, there was a loud crack, followed by a shudder felt throughout the ship. The operator of the braking device, fighting off sleep and weariness, had apparently been less alert than he should have been, and a quick take-up in slack had broken the cable. There was nothing left to do but give up and go back.

Field refused to be discouraged. With his friends he devised improvements in the machinery and raised money for a new cable, and on 10 June 1858, almost a year after the first try, he set sail once again aboard the *Niagara*. This time the *Niagara* and the *Agamemnon* were to meet in the middle of the ocean and head for opposite shores, paying out the cable on the way. Perhaps the most important piece of equipment was the mirror-galvanometer, invented by Thomson to pick up very weak electric

impulses and show them visually. With this instrument he could check at any point of the laying process whether the cable was still in order and the current getting through.

Two days out, the ships ran into wind and heavy seas; but this was nothing compared to the foul weather yet to come. By 21 June the wind had become a full gale, slapping gigantic waves against the hulls and swamping the decks. The wind screamed through the halyards; the close-reefed sails fluttered and cracked like whips.

Aboard the *Agamemnon* sacks containing tons of coal had been piled on deck to make room in the hold for the coil of cable. The roll and pitch of the ship tore the sacks loose and they were hurled in all directions, smashing ladders, crashing through skylights, breaking open and sending great chunks of coal tumbling down hatchways and into the engine-room. Frantic sailors, trying to stop the disaster, were knocked sprawling by the heavy sacks, and some were seriously injured. Water poured into all the cabins, and furniture was broken to splinters.

In the hold the great coiled iron worm was no longer neat and orderly. The pitching of the ship had changed the coil into a hopeless tangle until it resembled, as one man later wrote, a 'cargo of live eels'.

The ships rode out the storm and on 25 June the cable was spliced in mid ocean and the vessels separated, one heading for Newfoundland, the other for Ireland. Only an hour later the cable snapped aboard the *Niagara*, but thanks to the new machinery it was caught and spliced.

On 27 June, when the ships were forty miles apart, the cable snapped midway. The vessels met again, made a new splice, and started out once more. When they were 146 miles from each other the cable parted again, but this time it could not be recovered and the ships returned to port.

Cyrus Field refused to give up, for he was sure that the cable could be laid successfully. He was right; for they set out the third time on 17 July 1858, met in mid ocean,

spliced the cable, and laid it successfully. The *Niagara* brought her end of the cable to Heart's Content, Trinity Bay, Newfoundland, and the *Agamemnon* brought hers to Valentia Harbour, Ireland, both docking on 5 August. On that day the first message, sent by Thomson, arrived in the New World, which went crazy with excitement. It began: 'Europe and America are united by telegraphic communication . . .'

By 20 October more than seven hundred messages had been sent by cable across the ocean—and then the cable went dead. The insulation had not been strong enough to stand the strain.

Field and his friends had trouble trying to raise more money for a new trial, because potential investors had been discouraged by the failures; but Field kept trying and by 1865 he had raised about three million dollars for a new attempt.

This time they built a stronger, more flexible cable and decided to have it laid by one ship. The ship they chose was the *Great Eastern*, called by some the 'most stupendous and marvellous of steamships'.

The *Great Eastern*, built of iron and designed to carry four thousand passengers, was 680 feet long—twice the length of the *Niagara*—and weighed twelve thousand tons. In its day it was considered one of the modern wonders of the world, and only a ship of this size could possibly carry a weight as great as that of twenty-five hundred miles of cable. The manufacture of this new cable in England was personally supervised by Professor Thomson, and he again went with the cable-laying ship.

On 23 July 1865 the *Great Eastern* joined one end of the cable to the land end at Valentia Harbour and started across the Atlantic, but after laying nearly twelve hundred miles of cable the wire snapped and the ship returned to her home port. It seemed that the Fates were determined that Cyrus Field should not succeed—but Field was still full of fight.

A year later, on 13 July 1866, the *Great Eastern* tried again—and this time paid out the cable without a mishap, steaming triumphantly into Heart's Content, Newfoundland, on 27 July, where the connection was completed. A message was promptly sent out by Cyrus Field. It read: 'Heart's Content, July 27th. We arrived here at nine o'clock this morning. All well. Thank God, the cable is laid and is in perfect working order. Cyrus W. Field.'

Messages sent across the first cables and over the telegraph lines consisted of Morse signals. A more amazing development was yet to come—man would soon be able to send his voice over a wire.

The invention of the telephone is credited to Alexander Graham Bell, but Bell was not the first pioneer in this field. In 1837 Dr C. C. Page of Salem, Massachusetts, had an idea for the transmission of the human voice by electricity, but tests showed that it was not workable. In 1854 a French inventor named Charles Bourseul wrote an article about a telephone that might work but didn't. The article, however, inspired some worth-while work by a young German teacher named Philip Reis, who thought he could improve upon the ideas of Page and Bourseul.

Reis carved a piece of wood in the image of the human ear, in which he fastened a piece of pig's bladder as an artificial eardrum. Across the bladder he glued a narrow strip of metal foil as an electrical conductor, and he then arranged a piece of metal and a small nail so that the nail point touched the foil in the centre of the drum. This device was his transmitter.

The receiver was a home-made electromagnet, the core of which was a knitting-needle wound with insulated wire in the body of an old violin, because of the instrument's sensitive sounding-board. When electric waves were sent from the transmitter through the wire, the needle vibrated against the fiddle, making a crude reproduction of the sound.

Reis improved later models, which could transmit

musical sounds and speech; he demonstrated his invention to the Physics Association at Frankfurt in 1861, but it generated little interest and the device did not survive. In Germany, however, his fellow countrymen credited Reis with being the inventor of the telephone, a name which he himself gave to the instrument.

For the telephone as we know it we are indebted to Alexander Graham Bell, a Scotsman who migrated to Boston, Massachusetts, as a teacher of the deaf.

As a boy in Scotland, Bell was deeply interested in human speech. With his brothers, Edward and Melville, he made a model of a skull, fitted it with a bellows and with gadgets, and managed to make it cry 'Ma-ma! Ma-ma!' In their first successful experiment the boys made their artificial cry so realistic that their neighbours came looking for a child in distress.

Bell had a Skye terrier that was his constant and beloved boyhood companion. He taught the dog to growl steadily while he manipulated the animal's mouth and throat in an effort to teach it to speak. After weeks of effort the dog was able, with some help from its master, to say 'Ow ah oo, ga-ma-ma?'—meaning 'How are you, Grandmama?'

Somehow one of the Reis telephone sets had found its way to Edinburgh University, where Bell was studying natural science. The invention gave the young man's thoughts a special direction.

His brothers died of tuberculosis and Alexander himself was threatened with this disease. To save the youth, his father moved the family to Brantford, Ontario, Canada, where Alexander recovered his health. Then he began to teach speech to deaf children in Boston and [illegible]thampton, Massachusetts, and in Hartford, Con[illegible]ut.

[illegible]ction with his studies of human speech, Bell [illegible] with electrical signals transmitted by what [illegible]rmonic telegraph'. He expressed his aim in [illegible]f I can get a mechanism which will make a

current of electricity vary in its intensity, as the air varies in density when a sound is passing through it, I can telegraph any sound, even the sound of speech.'

Actually Bell wanted to find a way to send a variety of sounds over a wire so that more than one electric message could be sent at one time, distinguished by the differences of the sound waves. His invention of the transmission of a human voice came about partly by accident.

Bell's laboratory equipment had been built by his assistant, Thomas A. Watson, who helped him with his experiments in an attic at 109 Court Street, Boston. One day in June 1875 Watson tinkered with a transmitter in one room as Bell sat near a receiver in another. Each instrument had a group of upright metal strips of varying lengths (for various tones) fastened only at the bottom, set up close to a magnet that would cause the strips to vibrate when a current was sent through.

Watson was attempting to adjust one of the metal strips on the transmitter when the strip got stuck. He tried to pluck it free—and at the same time Bell noticed that one of the strips in the receiver vibrated too and made a faint sound. He leaped from his chair, ran into the other room, and cried, 'What did you do then? Don't change anything! Let me see!'

Bell examined the strips and discovered that the sound they made could be produced by current variations in the magnetic coil. Now he had correctly guessed the secret. Up to this moment he and the other inventors had experimented by using an intermittent electrical current, as in the telegraph, where a connection was made and then broken. Now he understood that the current had to be steady but of varying frequency.

Basing their work upon this discovery, Bell and Watson made an improved model of the instrument and obtained a patent for it on 7 March 1876. This first model transmitted tones of the human voice, but not intelligible

words. Soon Bell built another transmitter in an effort to send his voice to a nearby room where Watson was listening. By accident Bell overturned a container of battery acid, which spilled on his clothes. Momentarily forgetting his transmitter, Bell called, 'Mr Watson, come here—I want you!'

A few moments later Watson burst into the room. 'Mr Bell!' he cried. 'I heard every word you said—distinctly!'

In later years, recalling this episode, Mr Watson said, 'Perhaps if Mr Bell had realized that he was about to make a bit of history, he would have been prepared with a more interesting sentence.'

Bell's telephone was exhibited and demonstrated at the Philadelphia Centennial Exposition in June 1876. One of the visitors was Dom Pedro II, Emperor of Brazil. When he put the receiver to his ear and heard Bell's voice as Bell spoke into the transmitter some distance away, the Emperor was obviously startled. 'My God', he exclaimed, 'it talks!'

Other American inventors soon disputed Bell's claim to the invention, but it was upheld in the courts and Bell is acknowledged to be the inventor of the device that became our modern telephone.

When Bell went on his honeymoon trip to England—he had married one of his deaf-mute students from a speech-training course, and her father had financed his experiments—he took a set of telephones with him, and showed them to British scientists and business men. He was invited to demonstrate his invention to Queen Victoria at Osborne in 1878; she liked it so much that she had a private line installed from the Isle of Wight to London. Bell was also asked to lay a telephone line from the gallery of the House of Commons to Fleet Street, and through it a report of a debate was dictated for the first time to a shorthand writer in a newspaper office. A few months later the first general telephone service began to operate in London, run by the Edison Company; one

of its employees was twenty-three-year-old George Bernard Shaw—his 'last attempt to make an honest living', as he put it, before turning full-time professional writer.

The telephone, the cable, and the Morse telegraph required the use of wire to transmit messages, but in 1894 an Italian inventor named Guglielmo Marconi, a twenty-year-old student, began experiments to send messages without wires. Marconi's idea was based on discoveries made by two scientists, James Clerk Maxwell, an English physicist, and Heinrich Hertz, a German physicist. Maxwell, studying electromagnetism, predicted that man would some day send messages without wires. Hertz, after exploring Maxwell's findings, proved that electricity moves through the air in waves, and he actually sent wireless signals from one end of the room to the other in his laboratory; they were called 'Hertzian waves'.

Marconi himself said later, 'From my youth, I would almost say my boyhood, the experimental discovery of electrical waves made by Hertz had fascinated my mind, and I soon had the idea . . . that these waves . . . might furnish mankind with a new and powerful means of communication. It could be used not only across continents and seas but also on board ships.'

When Marconi was only twenty-one he was conducting experiments in his father's garden at Bologna, Italy, and soon he was able to send crude radio signals over two miles. Strangely enough, no one in Italy seemed interested in Marconi's amazing invention; so his Irish mother encouraged him to go to England to get money and support to continue his work.

In London, Sir William Preece, director of the Post Office Telegraph Department, was so interested in Marconi's device that he arranged for a demonstration to be given to important government officials. A distinguished audience gathered on the roof of the Post Office building and saw Marconi send electrical signals over a

distance of a few hundred yards without wires. Soon he was showing that 'tuning' could separate one station from another and that messages could be sent from ship to shore. These historic experiments took place in the Bristol Channel area in May 1897.

News of Marconi's feat reached the Italian Government, and he was asked to return home and install his 'wireless telegraph' in Italian battleships. This he did, and messages were sent between ships twelve miles apart. Other nations began to ask for Marconi's equipment, and he was suddenly famous and in great demand. Marconi, however, kept asking himself one great question: How far would his electric signals travel? Could they be sent all the way across the ocean and, if so, would they still be strong enough to be heard on the other side? Or would they simply shoot into the vastness of outer space and be lost for ever? There was only one way to find out. Try it!

On a rocky point at Poldhu, in Cornwall, Marconi built a high wooden tower from which a wireless signal would be beamed towards Newfoundland. Storms lashed the coast and high winds toppled the tower as though it were made of toothpicks. He built another, and it was also pushed over by gales. Finally he put up a sturdy tower that could withstand heavy weather, installed his sending equipment, and gave instructions to an assistant who was to operate it. Then Marconi and his helpers sailed for North America.

In December the Newfoundland coast was battered by wind and sea, and there was no time to build a tower such as Marconi had erected in England; but he had to have something that could raise a wire high into the air to catch the signal from Poldhu—if, of course, the signal managed to cross the sea. The only possible answer was a kite. The very wind that might tear down a tower could sweep a kite high into the skies.

On 12 December 1901 Marconi got his kite into the air and watched it dip and climb like some strange captive

bird as he unreeled his long line. The kite flew at an estimated height of four hundred feet, carrying a wire aerial connected to the ground. While an assistant held the kite line, Marconi went into the small wooden shack that housed his receiving equipment, and sat listening through a set of earphones. If the signal crossed the ocean and did not climb up into space, it should be caught by the wire aerial, transmitted to the shack, and picked up in his earphones. The signal previously agreed upon was a single letter of the alphabet—the letter S, three dots in Morse code—repeated over and over again.

Marconi listened for such a long time that he was on the verge of disappointment. Then he stiffened in his chair and pressed the phones tightly against his ears. Suddenly he tore off the headset and handed it to an assistant. 'Put this on', he said, 'and tell me if you hear anything.'

The assistant put on the earphones, listened intently, then grinned and shouted, 'Yes! Yes! I hear it—I hear the three clicks!'

Marconi had proved that signals could be sent across the sea without wires. He did not know it at the time, but the signal actually did travel off into space. It travelled more than two hundred miles above the earth—where it struck a layer of gases, called the 'ionosphere', which made the signal echo back to earth, like a ball bouncing off a wall. Today our radio-telegraph signals travel to distant points in this same way, making it possible to exchange messages and news throughout the world.

Radio communication was born of many minds and experiments. We have already seen that James Clerk Maxwell predicted that messages would one day be sent without wires, that Heinrich Hertz projected electrical waves across a room, and that Marconi succeeded in sending signals electrically across the Atlantic Ocean.

In 1883, long before Marconi's transatlantic experiment, Thomas A. Edison, American inventor of the

incandescent lamp and many other marvels, patented what was called the 'Edison effect'. Seeking to learn why his light bulbs were blackened on the inside, Edison suspended a small piece of metal near the filament in a bulb and ran a connecting wire to one side of the filament base. Outside the bulb he hooked up a 'galvanometer', an instrument which measures electric current and indicates the direction in which it moves.

When the bulb was lighted Edison was startled to see that current was flowing through his suspended piece of metal, or 'electrode', even though there was no wire or connection between the electrode and the filament itself. Although the experiment was interesting, the inventor did not see how it might be put to practical use. He did, however, obtain a patent for it.

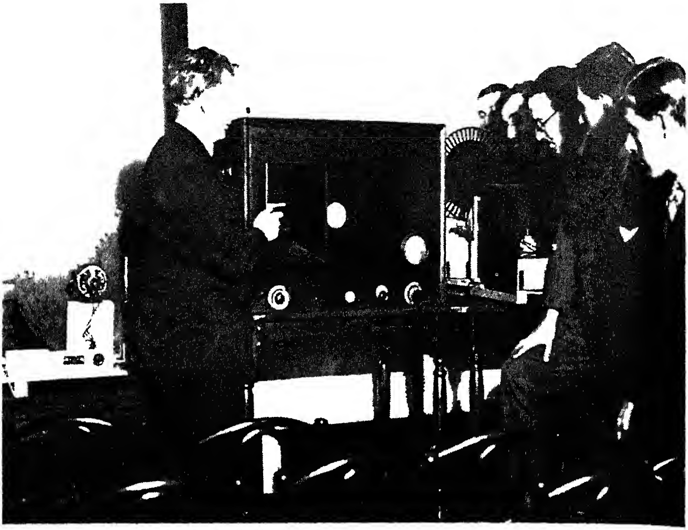
In 1904 Sir Ambrose Fleming, who had worked closely with Marconi, conducted some experiments to see whether or not the 'Edison effect' might be used to detect wireless or radio waves. Fleming added a second electrode to Edison's bulb—creating what became known as a 'diode' tube because it had two electrodes, one positive, one negative. The important finding was that it helped to rectify, or detect, radio signals to a limited degree.

Fleming's valve made it possible to amplify telephone waves, and now the question was asked: 'Would it be possible to transmit speech and music by wireless waves?' The answer came from one of the 'fathers' of modern radio and television—Lee DeForest, of Council Bluffs, Iowa.

DeForest patented more than three hundred electronic devices, but probably his most important invention was a radio tube which he called the 'audion'. In a series of experiments with Fleming's diode, DeForest wondered what would happen if he used three electrodes in the tube instead of two. He worked with a third electrode—in several different positions, inside and outside the tube—

Marconi with his transmitter (*right*) and receiver shortly after the successful attempt to send a wireless signal across the Atlantic in December 1901.

Sending a telegram by push-button. The Desk-Fax sends and receives messages in 'picture' form automatically.



Baird (*left*) demonstrating his experimental television receiver to the press in 1928

Television control-room, with the studio at the left

for a period of months before he discovered how to make his audion not only detect radio signals but also magnify, or amplify, and generate waves. By using several tubes he discovered that a weak signal could be boosted until it became strong.

DeForest's audion, or 'triode' (three-electrode tube), became the heart of radio, making possible and practical the transmission of speech, music, and other sounds through the air, to be captured and heard in far-away places.

In 1912 another American, Greenleaf Whittier Packard, discovered that certain crystals could be used as detectors, and by 1920 thousands of people were listening with earphones to radio programmes picked up by simple crystal sets from the world's first broadcasting station, in Pittsburgh, Pennsylvania.

It is not definitely known when the human voice was broadcast by radio for the first time. Some claim that a man named Stubblefield spoke to a partner in a localized test near Murray, Kentucky, in 1892. Others say that the first voice transmission was an experimental programme of talk and music sent by Reginald Fessenden from Brant Rock, Massachusetts, on Christmas Eve in 1906—a programme which was heard by radio-equipped ships several hundred miles away. But it is a fact that in 1907 some technicians in the British Navy transmitted 'God Save the King' from one ship to another during a world cruise. DeForest himself broadcast a performance from the Metropolitan Opera House in New York in 1910, starring the great Italian tenor, Enrico Caruso. In 1915 speech was first broadcast from New York City to San Francisco, and from Arlington, Virginia, to the Eiffel Tower in Paris. In 1919 a wireless scientist, Dr Hans Bredow, demonstrated the transmission of speech and music—and their reception by loudspeaker—in Berlin.

Records of the Department of Commerce in Washington, which first supervised radio transmission, show that

the first commercially licensed radio station was KDKA in Pittsburgh, dating from November 1920.

England was the first country in Europe which took up broadcasting, although it took some persuading until the authorities permitted the Marconi company to set up a station (with only 100-watt output!) at Writtle, near Chelmsford, in February 1922. The programme was rather poor, for no artist of repute could be tempted to travel into darkest Essex for a few minutes' performance—except the great singer, Dame Nellie Melba.

Experiments proved successful from the technical point of view, and in May 1922 London got its first station, called '2LO', operating from the top floor of Marconi House. At first the authorities imposed the absurd restriction that no music should be transmitted, but when it was lifted, hundreds of letters asking for more came from enthusiastic radio amateurs—the only listeners who had receiving sets, mostly home made. Public pressure for the introduction of a regular broadcasting service with a network of stations covering all Britain grew daily stronger, and at last the British Broadcasting Company, later Corporation, was formed by a number of radio equipment manufacturers. It was granted the exclusive right of broadcasting in the United Kingdom, and on 14 November 1922 the London transmitter began with its regular nightly programmes; Birmingham followed the next day, and Manchester soon after.

Today there are thousands of radio broadcasting stations all over the world—as well as thousands of short-wave stations operated by amateurs, or 'hams'. Police cars, taxicabs, planes, and ships are radio-equipped. The wireless receiver has become extremely mobile and can be made so small that it fits into a coat pocket—due to a brilliant invention, the transistor, made by a group of research workers at the Bell Telephone Laboratories in America in 1948. The transistor has now taken over the job of the amplifier valve in a large number of

instruments because it controls the flow of electrons much more economically; shorter than a match-stick and not much thicker, the transistor operates on a dry-cell battery of only a few volts, is virtually unbreakable, and has a very long life. Today radio is a vital link in military communication and has become an integral part of the daily lives of millions of men, women, and children. So, too, has television.

Television grew from the brains and hands of many people in many lands. Like radio, television was made possible by various discoveries in the late nineteenth and early twentieth centuries. In 1884 Paul Nipkow, a young German engineer, patented a 'scanning disc' for transmitting pictures by wireless. In the United States, William Jenkins began a study of this possibility in 1890 (and by 1925 he was demonstrating mechanical television apparatus). In 1915 Marconi predicted that there would one day be a 'visible telephone'. In 1923 Russian-born Vladimir Zworykin applied for United States patent on the 'iconoscope' (television picture tube). Other inventors made important contributions—Philo T. Farnsworth, Dr A. B. Dumont, and J. L. Baird. These are but some of the names that have gone down in radio and television history.

The last-mentioned, the Scottish parson's son John Logie Baird, must be credited with the first-ever transmission of a human face, on 2 October 1925, in a dingy garret in Frith Street, Soho. He had started his career as an electrical engineer, but had to give it up because of ill health, and tried his hand at various things, including jam-making in the West Indies and selling French soap in London. When he took up the idea of inventing television he had next to no money, his health was bad, and he had little knowledge of previous attempts to solve one of the most intricate technical problems of our time.

Baird's system used mechanical scanning by means of the Nipkow disc. With this primitive apparatus he

succeeded in transmitting the face of an office boy, from a firm below Baird's Soho garret, from one room to the adjoining one by wire. But three years later the B.B.C. made the first public television broadcast from his studio; in 1930 the first television play was put on the air, and from August 1932 the B.B.C. transmitted regular experimental programmes from a room in the sub-basement of Broadcasting House, which had been equipped as the first television studio.

November 2nd, 1936, was the birthday of the world's first regular public television service. The Baird system was then used alternatively with the Marconi-E.M.I. system, which scanned the pictures electronically with the equipment devised by Zworykin in America. A few months later the Baird system was dropped and the Marconi system finally adopted because it produced a much better definition.

For more than twenty-five years inventors tried to telecast pictures in colour. In 1927 Baird had already demonstrated an early system, and in 1929 colour pictures were sent over wire in a test at the Bell Telephone Laboratories in New York. The Radio Corporation of America gave an experimental colour television demonstration in February 1940, and the Columbia Broadcasting System tested colour telecasts the following August. Today colour television is in many American homes; and although special receivers are required for the colour pictures, the programmes are 'compatible'—meaning that they are clearly received in black and white on regular television sets. At the time of writing we are still waiting for the introduction of colour television in Britain.

Through the vision, ingenuity, and skill of many men we may now sit in our living-rooms and see and hear news events as they are happening; or university professors as they teach courses in science or languages; or symphony orchestras, opera stars, popular singers, politicians, philosophers, cowboys and Indians, poor actors in shoddy plays

or great actors in equally great drama—all depending merely upon the flick of a switch.

Drama, music, literature—the fine arts—are themselves channels of communication. As an example, consider one of the world's great historic stories—told through the use of needle and thread.

10

THE HEART OF ART

NEEDLE AND THREAD stories were woven into what we call tapestries—fabric of elaborate design—and as a form of communication they have revealed a great deal about ancient peoples and their ways of living. We read in the Bible about linen or canvas embroidered by hand or woven on looms, and in the palace of the kings of Babylon were tapestries in gold and silver telling the Grecian fables of Andromeda and Orpheus. Some have been found bearing Egyptian hieroglyphs. Probably the oldest known specimens of tapestry were two of linen, made around 1430 B.C., which were unearthed thousands of years later in the tomb of King Thutmose IV of Egypt.

One of the most famous of all tapestries, and one which is a magnificent example of the way in which thread and cloth have recorded lasting messages, is known as the Bayeux Tapestry. This is a strip of linen cloth 231 feet long and about twenty inches wide on which the story of the Norman conquest of England was embroidered in threads of eight colours. The whole story is told in seventy-two scenes with some 530 characters and with legends in Latin interspersed with Saxon, all representing a task of embroidery which must have taken years to complete. Some authorities say that it was made at the request of Queen Matilda, wife of William the Conqueror, while others believe it was inspired by the king's half-brother, Odo, Bishop of Bayeux. One source says that the sewing itself 'might, with much probability, be attributed to a

female embroiderer of Queen Matilda, named Leviet, whose skill has rescued her name from oblivion'. The tapestry is today in the Bishop's Palace at Bayeux, Normandy.

Art in many forms has built a bridge between our civilization and all those that preceded it. The cave drawings of the Stone Age and the discoveries of the archaeologist have revealed many aspects of the life and times of primitive man.

Picture stories carved on ancient pottery, on clay tablets, and on the walls of tombs have told us much about civilizations that once flourished and died.

Ruins of buildings that were truly magnificent in centuries past have not only thrown light on the skills and crafts of peoples who loved beauty and power, but also have given architects in our own time artistic ideas and patterns for creating monuments, office structures, and homes that are pleasing to the eye.

The sculptor has left us his statues of clay and marble and bronze so that we may see the faces and forms of people of his day, both famous and nameless.

The painter has given us even more, for he has shown us not only the people's faces and bodies but also the costumes they wore, the food they ate, the weapons they carried, the games they played, the markets they patronized or owned, the ships they sailed, the jewellery they made, the homes they built, and the animals they raised—all in the purples and greens and whites and blues and yellows and other colours that bring life to the painted image.

Many paintings, of course, communicate by telling actual picture stories or by showing some aspect of life in the artist's day. The Dutch painter Jan Vermeer (1632–1675), for example, portrayed people of his own era, and in his paintings we can see the kind of clothing they wore, the kind of furniture they had, the things they used, the framed paintings on their walls.

One of the greatest of all artists, Rembrandt van Rijn (1606–69), painted many portraits of himself. These, of course, show us what Rembrandt looked like; but the originals also bring us close to his day when we realize that we are looking at the very paint he himself applied to his canvas, and the image he presented as he worked. There are copies of his portraits; but the best copy is only an imitation, and the feeling communicated is not quite the same as that we get from seeing the original.

Not all art communicates by story-telling. Art, whether painting or sculpture, or poetry or literature or music, is an outlet for the artist to express emotion through form, colour, and composition. To some of us a painting of an apple tree in blossom may be simply 'pretty'; but to one who can see the tree as the artist saw it, and who can grasp the feeling that inspired the artist, the painting can communicate deep emotion and an appreciation of beauty which others less sensitive will never feel or see.

Music is another art that communicates. No one knows when the first musical note was sung or played. A primitive child may have tried to imitate the song of a bird, or a cave man might have wailed or chanted in anger when a deer escaped his spear.

Scholars have learned that more than twenty-five thousand years ago cave men cut notches in a bone and then rubbed a stick or stone across the ridges to make a rasping noise, perhaps to create rhythm for a song or dance. Primitive man is also known to have bored small holes in the bone from a reindeer's leg to make a crude kind of pipe or flute which would produce pleasant whistling sounds, and for all we know the idea for the lyre or other stringed instrument may have come from the musical twang of the bowstring of a primitive hunter. From pictures left by the Stone Age people, however, it seems that their instruments were not used for happy songs or lively dancing, or entertainment, but instead were designed to frighten enemies and to drive away demons and evil spirits.

We have seen how the drum has been used to telegraph messages. The drum was also one of the first musical instruments; and even today it is used by primitive peoples to provide rhythm in various rituals and ceremonies, and as an accompaniment for singers of traditional songs. In the United States the drum was used constantly by the American Indian tribes, who created their own unique music, not only for incantations to the Great Spirit but also to tell or sing stories of the achievements of their chiefs and braves.

These Indian songs were childishly simple, yet in a way they are reminiscent of the stories carried from village to village in Europe by minstrels and troubadours during the Middle Ages. These story-tellers made their living by playing stringed instruments, such as the lute, in towns and palace courtyards or halls, and singing about wars and romances and even gossip of the day. Since the minstrels were always on the move, listeners gathered to hear stories of people in other places and to get whatever news was to be had. Around 1400 most of the noble families had permanent staffs of minstrels—as, in later centuries, the princes, kings, and emperors all had their court musicians. But with the introduction of the theatre and the printing press the minstrel disappeared.

For ages music, like painting, had been widely used in churches and for religious purposes, and gradually it grew into a form of entertainment. The ancient Greek dramas were accompanied by 'choruses', and it is probable that the dialogue of the Greek tragedies was recited in a musical way.

Late in the sixteenth century a group of musicians and artists assembled in the home of Giovanni Bardi in Florence, Italy, to try to create a new musical style using the Greek lyric drama as a basis from which to work. After considerable effort this small group, in 1597, staged what was undoubtedly the first real opera—*La Dafne*—composed by one of the members, Jacopo Peri.

Soon other composers recognized the power and beauty of operatic story-telling and began to write scores with richer harmonies requiring more musical instruments. In 1637 the first public opera house, the Teatro di San Cassiano, was opened in Venice, and was a great success from the beginning. Since that time opera has spread over most of the world, telling in musical masterpieces such great tales as *The Mastersingers*, *The Barber of Seville*, *Il Trovatore*, *Don Giovanni*, *Fidelio*, *Der Rosenkavalier*, *Madame Butterfly*, and many others.

Today photography and the film play an important part in communication. Our descendants will have a wonderful pictorial record of our lives and customs, thanks to the camera.

The photographic and film camera has its origins in the *camera obscura*, which Leonardo da Vinci described in his famous notebooks: when light rays enter a small hole in a dark room or box, they throw an upside-down picture of the outside scene on the opposite wall of the box. A German monk, Zahn, improved the *camera obscura* by fitting a lens into the hole, which made the picture sharper.

In the early nineteenth century two Frenchmen, the ex-officer Niepce and the former showman Daguerre, tried to find some chemical substance which would react so strongly to light and shadow that the picture in a *camera obscura* could be made permanent and taken out for everybody to see. Daguerre succeeded at last in 1839; he used a metal plate coated with silver iodide, and 'developed' the picture on it with mercury vapour.

These 'Daguerreotypes', as they were called, could be neither copied nor enlarged. Photography as we know it today, with a 'negative' original and 'positives' made from it, was the invention of an English scientist, William Henry Fox Talbot, who used sensitized paper for both the negative and the positive images; he called his system 'calotype' and took out a patent for it in 1841. A few

years later Niepce's nephew—Niepce de St Victor—had the idea of using glass plates, coated with sensitive chemicals, as negatives.

In the decades that followed many improvements were made in photography; eventually the glass plate was replaced by the celluloid film, and inexpensive cameras were produced by George Eastman of 'Kodak' fame. And today good cameras and high-speed film are available—for black-and-white or colour snapshots—to millions of people in all countries.

Towards the end of the nineteenth century a number of inventors in various countries tried to make the good old magic lantern, which had amused generations of children and grown-ups, come to life with the help of photography. Scientists had discovered that a series of 'still' pictures showing subsequent phases of movement, if shown rapidly enough, would create the impression of continuous movement because of the 'inertia', or laziness, of our eyes, which retain for a fraction of a second what they have seen; thus one still picture would overlap, as it were, the following one, and we should have the impression of watching a moving scene. It was a couple of French brothers, Louis and Auguste Lumière, manufacturers of photographic equipment at Lyons, who won the race; in December 1895 they opened the first cinema in Paris, showing films which they had shot with their cinematographic camera; these were projected by a magic-lantern type of apparatus, also designed by the Lumières. The first film show created a sensation; soon the cinema conquered every country in the world, and it has remained with us ever since as the most wonderful means of visual entertainment. When, in 1928, the hitherto silent film was given a voice (by means of microphone and loudspeaker), the cinema grew into a major 'industry' in many lands. Even the television screen has not been able to displace the cinema screen in our affection. Drama and newsreel, comedy and documentary, human problems and great events, Mickey

Mouse and Moby Dick—the variety of our film fare is indeed infinite, and we are lucky that we are able to enjoy what people in former centuries could never dream of seeing.

All of us today are directly affected by visual methods that have grown from the first cave drawing. Our newspapers are filled with pictures—not only those that have news value but also those that advertise practically everything from pencils to electronic brains, from clothes to motor-cars.

When we drive through the countryside, or through the city, we see words and pictures on hoardings, or in shop windows, or on the sides of buses and delivery vans.

In the class-room we watch the teacher draw a diagram or picture on the blackboard to illustrate some fact or theory. A photograph published in a textbook helps to make clear some of the explanations in the text.

In the newspapers we turn to what are called 'comic strips' to follow the adventures of our favourite cartoon characters. The cartoon, incidentally, has given us the familiar figures called John Bull and Uncle Sam, and has often criticized politicians to good effect.

The Chinese philosopher who is supposed to have said, 'One picture is worth ten thousand words' remarked in fact, 'One seeing is worth a hundred hearings.' One hearing, however, might mean more than a million seeings, depending upon circumstances—as, for instance, to a modern astronaut, strapped in a sealed capsule, fifty thousand miles out in the blackness of space, whizzing towards the moon, his only communication the sounds of voices captured electronically from the earth and transmitted through the wires in his helmet.

11

HEY, VENUS!

MAN'S ADVANCE into space began in October 1957, when a Soviet rocket carried the first satellite 560 miles up into space, where it began to circle the earth at a speed of 17,000 m.p.h. Other Russian and American satellites followed in great numbers. In April 1961 the Soviets again scored by putting the first man, Major Yuri Gagarin, into orbit in a space capsule; the second manned space flight was again a Russian success: Major Gherman Titov completed seventeen orbits in August 1961. Six months later America's Lieutenant-Colonel John Glenn and another three months after him Lieutenant-Colonel Scott Carpenter each completed three orbits. In August 1962 it was again the Soviets' turn—they launched *two* astronauts, Lieutenant-Colonel Andrian Nikolayev and Lieutenant-Colonel Pavel Popovich, into space in separate vehicles within twenty-four hours; they remained in orbit for a few days and communicated with each other by radio telephone. This magnificent exploit was planned as a step towards establishing a large space station circling the earth for years, and serving as a 'stepping stone' for man's first trip to another planet—the moon, with Mars and Venus to follow within our lifetime.

How is an astronaut accommodated in his space vehicle? How is he protected against the strain of acceleration? How does he stay in his seat under the strange condition of weightlessness when the gravitational pull

of the earth is cancelled out by the centrifugal force produced by his rapid movement around our planet?

The capsule is shaped much like a huge ice-cream cone. Across the wide end is a form-fitting couch (moulded to the contour of each man) on which the pilot lies, facing the small end of the cone. The couch is shaped so that his legs bend at the hips and knees, his body resembling a rough letter Z. If you were to tip over a straight chair with its seat vertical and its legs parallel to the floor, and then sit in the chair in that position, you would approximate the position of the astronaut on the couch. In this way he can better endure the terrific acceleration pressure at take-off—and when the capsule goes into its trajectory, or curve, and travels horizontally, the pilot will then be brought into a normal sitting position. But he can shed his space harness at will, get up, and float in his cabin, experiencing the dream-like sensation of weightless floating.

The capsule is a shell within a shell. The outer casing can absorb much of the heat energy and reduce the danger of penetration by meteorites, while the space between the casings serves as insulation and deadens sound. Close to the pilot's hand as it hangs normally at his side are manual control devices. Before his eyes is a navigation periscope through which he can see his surroundings, and in the small end of the cone are 'pitch and yaw' jets which keep the vessel in stable flight.

At the small tip of the cone is a 'horizon scanner' which continually keeps the pilot orientated—in other words, a device that tells him which way up he is.

Finally, and perhaps most important of all, is his communication system. This is his only contact with other humans, and many scientists and other experts wait breathlessly to hear reports from the men they have catapulted into space.

Photographs taken in outer space furnish scientists with invaluable research material, and television pictures are

ideal for this purpose. Leonard Jaffe, Chief of Communications for the National Aeronautics and Space Administration Satellite Program, had this to say about telecasts from outer space:

'One of the most interesting things that we can do if we are to approach other planets with our space vehicles is to take a picture of the surface of the planet, and if we take a look at the amount of power required to send a television picture back from a planet, say Mars, we should end up with a figure of *ten billion watts*—a formidable amount of power.'

Accordingly Mr Jaffe suggested certain methods that might be used to reduce this amount of power. For example, instead of sending a continuous television signal back to the earth, they could take one picture of a planet's surface and store this picture on magnetic tape. Using the tape, the picture could be sent back at a very slow rate when the vehicle approaches the earth again, which would cut the need for power to a tremendous degree. The Russians used this system in their Lunik III, which succeeded in photographing the far side of the moon.

Another system might use a camera with film on a rotating drum. Said Jaffe, 'We should again take a picture of a very broad segment of the planet's surface. The picture would be deposited on the film. The film would be automatically developed and perhaps a facsimile scanner could look at this drum while it rotates, read off the picture very slowly, and transmit this information back to the earth.'

By such 'storage' techniques Jaffe believes that this need for ten billion watts can be reduced to something like ten million, a very significant decrease in the power requirement.

Another advance is in the use of special satellites for world-wide communication between continents. In 1959 the Committee on Science and Astronautics of the U.S.

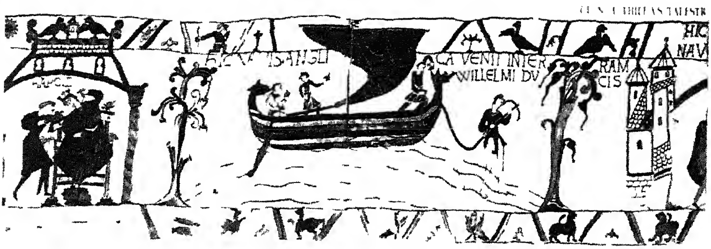
House of Representatives investigated existing communication facilities and the need for more.

'The idea of using a satellite as a communication relay device is not new', said the committee. 'In 1946 the possibility of using the moon as a world-wide communication relay was considered, and technical papers were published on the subject. Again in 1955 one of the country's leading communication corporations undertook to study the possibilities of transoceanic communication using man-made satellites.'

In July 1962 the first communication satellite, called Telstar, became a reality, writing another chapter into the history of the exchange of signs and ideas from man to man.

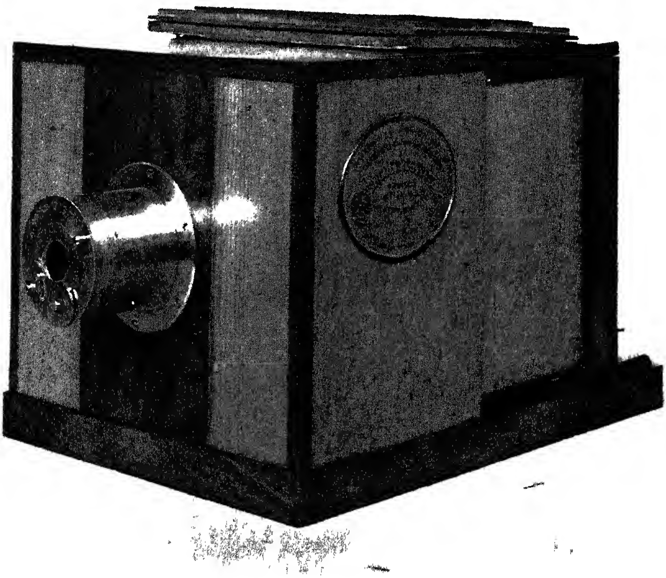
The 170-lb. satellite, successfully launched from Cape Canaveral into its 18,000-m.p.h. orbit at an altitude of 500 to 3,000 miles, transmitted television pictures and telephone calls from America to Europe and *vice versa.* The signals coming from ground stations were received by the satellite, amplified, and immediately retransmitted to the earth; storage batteries and solar cells, fed with energy from the sun, provided the necessary power. After a few initial snags had been overcome, Telstar proved that in this way instantaneous television between the two continents was possible with the same high quality of vision and sound as if they had come from a local transmitter.

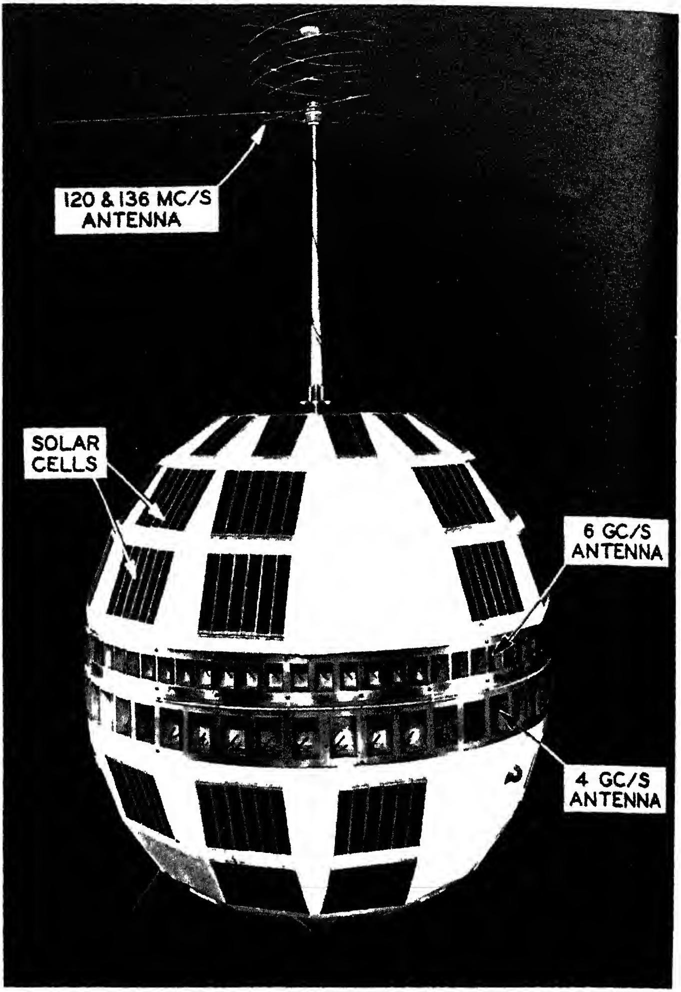
However, Telstar's job was not only to provide transatlantic entertainment. It had to test the scientists' and engineers' idea of creating an efficient new telephone link, thus relieving some of the pressure on existing cable and wireless links. In 1950 there were $1\frac{1}{2}$ million transatlantic telephone calls; ten years later the figure was 3 million, and it was estimated that by 1970 it would well exceed 20 million. Telstar succeeded in establishing, during the first few days of its orbiting, telephone communication between twenty-three European and as many



The story of the Norman Conquest told in a tapestry 231 feet long.

A Daguerreotype camera, about 1840.





Telstar has written a new chapter in the history of communication

American towns; up to about eighty conversations could be carried on at once, and a number of such satellites could keep up continuous intercontinental communications.

Telstar was followed by Relay and, on 14 February 1963, by Syncom, to provide a link between North America and Africa. Syncom, with a twenty-four hour orbit at the very high altitude of 22,300 miles above the equator, remains in position over the same longitude of the earth. Only three 'advanced' Syncoms could provide a world-wide communication link.

A more economic way of providing a communication relay station in space has also been tested by the Americans: a large balloon made of plastic sandwiched between layers of aluminium foil, from which signals are reflected back to earth, though not amplified. The balloon, which weighs only 65 lb., is carried by rocket up to a height of 950 miles and then automatically inflated to its full size of 135 feet diameter.

So many progressive changes are being made in space exploration that some of the communication devices we have described as experimental will be realities by the time this book reaches print—or may have been superseded by more modern inventions. Thanks to our newspapers, however, we can keep ourselves informed about new developments as they occur. The real point is that man has crossed the space frontier, just as his ancestors crossed the Mississippi, or the Alps, or the oceans; and now he seeks to consolidate his gains and to establish communication lines just as his forefathers did before him. No one knows what the mind of man can yet conceive.

The mind of man is yet another frontier that is continually under study. It is said that man can achieve whatever his mind can conceive. Can man transmit messages by his thoughts alone? Who is to say that he cannot? The possibility of this kind of communication has been under study for a long time, and various universities in the United States and Europe have conducted

interesting experiments in 'parapsychology'. The Parapsychology Laboratory at Duke University in Durham, North Carolina, supervised by Dr J. B. Rhine, is the largest of its kind in the world.

Many people have heard strange tales about events that happened in one place and were suddenly made known to persons far away. Emanuel Swedenborg, the Swedish scientist and philosopher who lived from 1688 to 1772, was in Goteborg, Sweden, in 1759, when he told the city authorities there about a fire that had just occurred in Stockholm, some three hundred miles away. He described the fire, named the owner of the house that was burned, and told when the blaze was extinguished. If the authorities doubted his report they had no doubts several days later when a royal messenger arrived from Stockholm. The messenger's news included an account of the fire exactly as Swedenborg had given it, even to the name of the owner of the burned building.

One day a minister and his wife—to quote a more recent story—called at Dr Rhine's Parapsychology Laboratory in Durham to tell about an experience of possible interest. Their home was in Chicago; but they had made a trip to Europe, and while they were in Switzerland the wife was suddenly gripped by a strong impression that her sister in Chicago had died. She considered this unreasonable, for she had left her sister in good health, and she did not mention the feeling to her husband. A few days later, however, she had an equally strong impression that her sister's body was being buried. This time she told her husband about her experiences, and he made a note of them. Shortly afterwards they reached another city, where mail and messages were awaiting them, and found that the sister had died on the day the minister's wife experienced the strange sensation, and that the funeral had been held on the day the wife received the impression of the burial.

These are examples of clairvoyance rather than telepathy. Telepathy involves the transmission of thought between

people, while clairvoyance concerns a knowledge of events without thought-sending.

In conducting telepathic experiments Rhine and his associates use various kinds of tests, including some with a special pack of cards called an E.S.P. (extrasensory perception) pack. This consists of twenty-five cards of five different designs: a five-pointed star, a square, a circle, a cross, and three horizontal wavy lines.

In the 'General E.S.P. Test' one person (the 'sender') shuffles and cuts an E.S.P. pack and looks at the face of each card, while another person (the 'receiver') attempts to read the sender's mind and identify the card on which the sender is concentrating. When one card is finished the test goes on to the next card, until the pack is finished.

In this test, using five sets of the five designs, there is one chance in five that the receiver will merely guess the correct card, or five chances for the whole deck. In 1933 a series of experiments with these cards at Duke University marked a milestone in studies of extrasensory perception.

J. G. Pratt, a graduate psychology student who was Dr Rhine's assistant in E.S.P. research, used a standard pack of E.S.P. test cards. In another building one hundred yards away Hubert Pearce, a Divinity School student, attempted to identify the cards as Pratt looked at them one by one. The two men had synchronized their watches, and one minute was given to each card. Two runs through the pack were made each day for six days.

Dr Rhine tells the rest of the story: 'Duplicate copies of the records were made, and before they got together to check the number of successes, or hits, each man sealed up one copy to be turned over to me. In the total of three hundred trials that were made in the series, the number expected on a theory of chance was sixty, or 20 per cent. Actually a hundred and nineteen hits, or approximately 40 per cent, were made by Pearce. Such a result could hardly be thought of as explainable by chance, for it would

not be expected *once in more than a trillion* of such experiments. Even the possibility that the two men might have entered into a conspiracy to produce the scores fraudulently was ruled out by later experiments in which I was present and watched the operation at Pratt's end of the test. Nothing, then, but E.S.P. could explain the results.'

Animals as well as humans may possess some kind of psychic power. One family—or so the story goes—is grateful to its pet cat for saving the lives of two boys. The boys' parents drove them to a forest some ten miles from their home where the boys were to camp out for the night, as they had often done before, and the parents then returned home.

Some time after midnight the cat did something it had never done. It cried and howled like a miniature fire siren, waking the boys' father and mother, and nothing they could do would quieten the creature. The mother became upset, insisting that something was wrong with her sons and that the cat sensed it.

To recover their peace of mind the parents dressed and drove back to the forest. Even as they approached they could see the trees aflame and men beating at the fire. The boys couldn't get out the way they had gone in; but their father drove to the opposite side of the woods and down an old dirt road, where he found and rescued his terrified sons.

Did the cat *know*?

There have been many cases in which families have moved from one city to another, sometimes hundreds of miles away, leaving behind a pet dog or cat for one reason or another, only to have the animal turn up weeks later at the new home it had never seen before.

Who can say what unknown forces are concealed in man's mind—or what undiscovered powers lie there waiting to be released, like Aladdin's genie?

In Britain the Society for Psychical Research has been conducting experiments for many years, many of them

carried out by men like Gilbert Murray, Whateley Carington, G. N. M. Tyrrell, and Dr Soal. One of the most interesting contributions to the problem of telepathy, however, has come from Poland, where Professor Stefan Manczarski has come to the conclusion that thought transmission works by means of electromagnetic waves of a low potential, but spread over a wide frequency band—from a few centimetres to extra-long waves of thousands of miles in length, all produced unknowingly by the human brain. In a book published in 1961 Professor Manczarski probed into the fascinating relationship between parapsychology, radio physics, and cybernetics, the science of the electronic computer.

Professor Kroghman, an anthropologist at the University of Pennsylvania, gave a scientific address in which he predicted what our culture would be like a million years from now. The prediction included the assumption that *all* communication would be telepathic.

Granting the possibility that some day we may be able to transmit messages by mind alone to our explorers in outer space and elsewhere, until that day arrives we must depend upon the electronic and mechanical devices which we already have and which are constantly being improved.

There is, however, a very ironic aspect to the gradual advancement of man's last frontier—outer space. The human explorer who is first sealed in a space capsule and rocketed to Mars, Venus, or some other member of our solar system may find that his landing-place is inhabited by other reasoning beings like himself. If it is, then he will climb out of his flying metal case to meet and talk to them. Since it is not likely that they will speak English, if indeed they speak audibly at all, or that he will speak their language, then he will be compelled to communicate with them by grunts, giggles, and talking hands—the way in which man began!

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